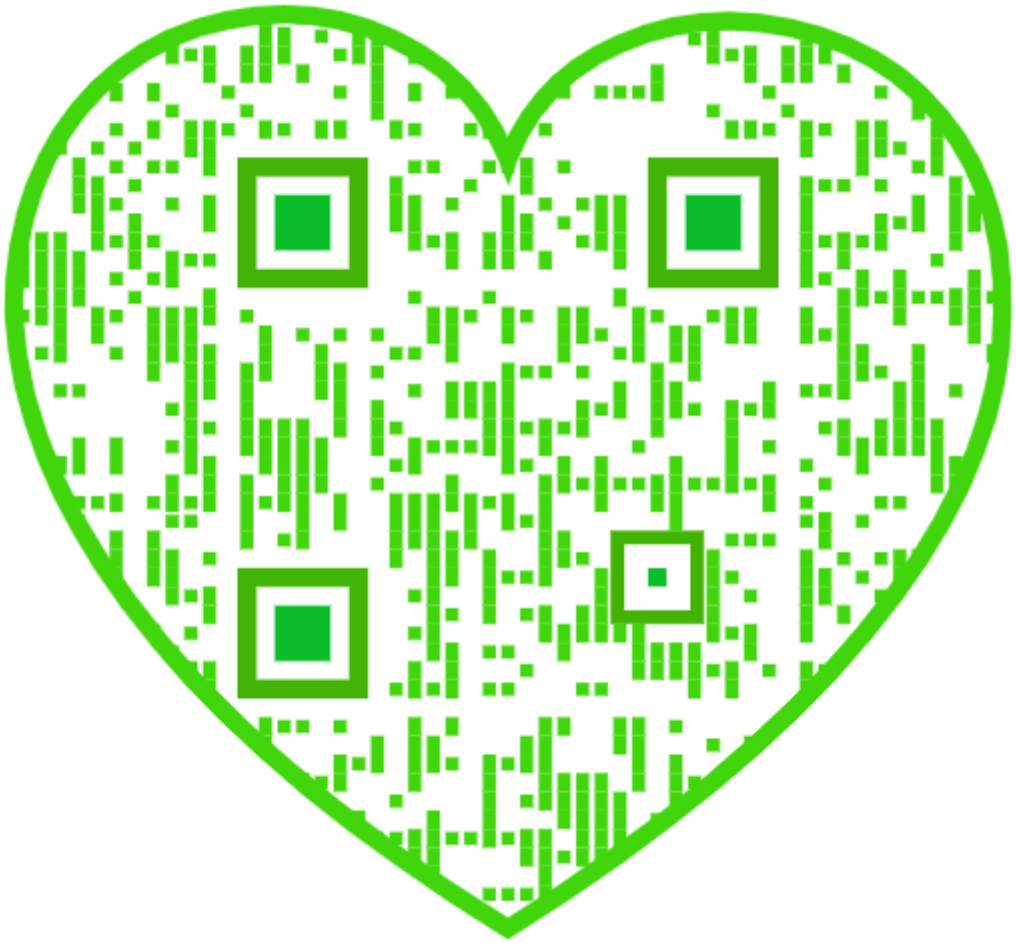

COURSE ON

CARE OF TREES

By

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TREE EXPERT

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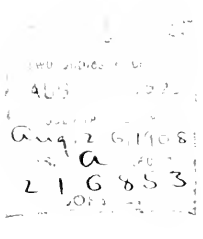

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CARE OF TREES

LIFE AND GROWTH OF TREES

Life

In taking up the discussion of the care of trees, the first things to consider are the anatomy and physiology of tree life. We must understand the tree itself before we can intelligently care for it. We must know the conditions and environment most favorable to it and understand the food it needs and know how and where this is obtained. We must also know the way this food is assimilated and digested and changed over into tissue. And then, in order to preserve the health of the tree, we must also be familiar with the enemies which attack it, and it is necessary to understand the enemies in order to combat and overcome them.

How does a tree grow and why? Life is truly a wonderful thing. We seldom consider how wonderful, and even when we allow ourselves to ponder on this great subject, or study it carefully and intelligently, we are wholly unable to grasp the wonders and marvels and magnitude of it. The subject is unquestionably so much greater and so far beyond our comprehension that we are only faintly able to realize its meaning and feel that we are only a part of it, an important part to be sure, but still only a manifestation of it.

And yet, in us, life is so highly developed that we may intelligently think and consider and study the great laws of life, that same life which renders us the very privilege of living and experiencing and thinking.

Kinds of Life

At once we find that everything which comes within the source of our knowledge may be classed under two heads—those things which are animate, and those which are inanimate. Those which are animate are composed of those which are or have been inanimate and they will finally return again to the inanimate state. Therefore, everything animat depends upon things inanimate.

Again, we find that everything animate is divided into two great divisions or kingdoms, the animal kingdom and the vegetable kingdom.

Starting with the highest types of each kingdom—man on one side and trees on the other—and working down through the succession of lower forms of life from which they have been developed by the progress of evolution, we find that the two lines approach each other more and more the lower we go.

That is to say, there is less difference between the lower specimens of animal life and vegetable life than there is between men and trees. Finally, if we go back far enough we find living organisms which we are unable to classify as either animals or vegetables.

In other words, the two lines have approached each other and finally met, which means that animals and vegetables originated from the same source.

In this case we have followed the lines backward; but the most logical way is to begin with the lowest orders of life and then work up, just as the development was made in the history of progress.

Evolution

In the lowest forms of life a single cell is able to perform all the functions. A one-celled organism merely consists of a mass of protoplasm containing a nucleus surrounded by a cell wall. The organism breathes, feeds, digests its food, throws off the waste and reproduces itself all in one tiny microscopic cell.

The first step of progress occurs when a group of connected cells learn to live together like a sort of family, but each still performing all the duties of its own life. Then occurs an important and economic step of evolution. This family learns that it can live better and far more easily if the duties of life are divided among the different cells. Each cell or group of cells undertakes certain chores. Some procure the food for the family, some prepare and cook the food, some dispose of the garbage, and others spend their time in rearing children. As they are then able to devote all their time and energy to their special tasks they soon learn to do them better and accomplish better results.

This differentiation of tissues for the purpose of specializing, is the keynote of evolution and as a result of it trees as well as men possess wonderful anatomies with highly developed tissues and organs.

Referring again to the lower forms of life, the organisms soon learned that they must procure their food in one of two forms, either in a soluble condition or an insoluble condition; and the choice of these two methods was another very vital step in evolution, for upon the result of the decision rested the future adjustment of the animal and the vegetable kingdoms. Those organisms which learned to engulf their food in an insoluble form and to make it available internally were the progenitors of the animal kingdom. By further specialization of tissues, acquired by necessity, they soon developed the characteristics of animals, and, as their food would not come to them in an insoluble form, they were forced to develop means of locomotion by which they could go in search of it.

On the other hand, those organisms which learned to take their food in solution developed roots and root systems and other characteristics of vegetables. Moreover, as their soluble food was brought to them there was not a sufficient need of locomotion to develop the means of it, and therefore they adapted themselves to a sedentary life.

Throughout the long ages the results of evolution were becoming more and more marvelous. The progress, born of necessity and occasionally of accident even, continued slowly but surely. During the different periods, many side branches arose as diverting lines of progress and the success of these was worked out in each case by the principles of "breeding by selection." That is, if the specimens produced by each diverting line were able to successfully perform their functions and successfully cope with the difficulties and enemies encountered, they continued to prosper, and their offspring found an easier existence. The origination of these diverting lines and the amount of success which attended their progress is represented by the various kinds of plant life which we find about us today, and each peculiar member of the vegetable kingdom tells us of an offshoot somewhere in the history of progress.

The various offshoots were not equally successful. The paths which some chose were not as easy to travel as others, and the difficulties they encountered retarded their progress; but the existence continued in every line which is represented by living specimens today, and the fact that any specimen of the vegetable kingdom is of a high order or a low order of plant life tells us something of the story of obstacles which have made war against its progress.

Thus, the different forms of bacteria branched off at the bottom of the ladder and never proceeded any farther on the journey. The higher forms may have developed from some enterprising or fortunate kind of bacteria, or they may have started from some lower point on the ladder.

The mushrooms and other fungi were unable to proceed very far because of the lack of chlorophyll or green, starch-producing matter.

The mosses fell far short of the grasses in their progress; and the grasses were unable to ascend higher on the ladder because they only provided themselves with terminal buds and neglected to add the lateral buds which would permit branching.

Of course, many of the diverting lines were finally unsuccessful and consequently died out. We have learned of some of these through fossil remains discovered in prehistoric strata.

The trees which we have today are the results of very successful progress. Evolution has by no means ceased, however, and man is learning to aid nature and direct the lines of progress into the most propitious channels in order to hasten evolution and force the vegetable kingdom to yield him a more bountiful supply of improved productions.

Some knowledge of evolution is most appropriate to the study of the life and growth of trees, just as English history previous to year 1776 is truly the history of the American people, and necessary for an understanding of existing conditions.

Growth

Every organic growth is made up of cells. Those cells in a tree which compose the tissues and organs of reproduction have become highly specialized. They are represented by the fruit buds, which develop the flowers, fruits and seeds.

Flower and Seed

The flowers may appear singly or in groups. The individual, complete flower is really a system, composed of four sets of organs, which are in reality modified leaves. They are the calyx, the corolla, the stamens and the pistils.

The calyx is composed of several sepals, usually green and their function is to serve as a protection to the flower previous to the development of the fruit bud.

Just inside the calyx is the crolla composed usually of several parts called petals. These serve as a protection to the stamens and pistils after the flower has opened. The corolla is generally colored to attract insects so that the pollen may be distributed and the blossoms fertilized.

These stamens lie just inside of the corolla and each is composed of two parts. The filament, or anther stem supports the anther which produces the pollen.

In the centre of the stamens are arranged the pistils which usually unite into one. A pistil is made up of three parts, the upper of which is the stigma. This is usually flat and sticky in order to receive the pollen. The stigma is supported by the style which connects it with the ovary, a hollow pod containing ovules. The ovules are minute undeveloped seeds. When the pollen alights on the stigma a tiny filament, containing protoplasm starts out from the under part of the pollen grain and grows down through the stigma and style into the ovary and ovules, and when the ovules receive this protoplasm from the pollen they develop into seeds.

This action is called fertilization, and generally takes place between the pollen grain of one flower and the ovules of another rather than between the parts of the same flower. Generally the infloresence is not composed of perfect

flowers, and most trees have two kinds of blossoms. The male or staminate flowers produce the pollen, which is carried by the wind, the bees, and other agencies, to the female or pistilate flowers. Those trees which produce both kinds of blossoms on the same specimen are called monoecious (meaning one household).

Other trees have a more complete differentiation, so that all the blossoms on one specimen may be staminate flowers, while all the blossoms on another are pistillate. Such trees are called dioecious (meaning two households). If we examine the maples just after blossoming time, we find the ground covered with fallen staminate flowers which have done their work and been discarded. But the pistillate flowers remain upon the trees. The corollas become withered, but the ovaries continue to develop the seeds.

The fruit is the ripe ovary and pistil. It contains the seeds and furnishes nourishment as an inducement to birds and animals in order that the seeds may be scattered. Fruits are developed in many different ways and according to the methods of development they take on various characteristics such as the fleshy fruits, like apples and berries; the stone fruits, like peaches and cherries; the nuts; the pod fruits; the legumes, like the peas and beans of locusts and yellow wood; the key fruits, like the maple seeds; and the cone fruits, like the pine seeds.

The ripened ovules or seeds contain the young plants in embryo, together with starch, albumen or oil, which serve as nourishment at the time of germination until the young roots are produced.

When the grain of pollen from anther drops upon a stigma and the filament is sent down into the ovule, the tiny drop of protoplasm creates a spark of life in the ovule and a single microscopic cell is formed. This grows and finally divides until two united cells are formed each with its cell wall, containing a drop of protoplasm, that mysterious solution of minerals which seems to be the fire of life; and floating in the protoplasm is the nucleus which seems to be the very essence of life.

One of the parts is to become the root system of the young plant and the other part is to become the stem and crown. The cells continue to multiply in all directions and thus the embryo is developed.

Development

When the seed falls to the ground and germination takes place, the seed leaves, or cotyledons, unfold and a tiny bud, the plumule, appears which forms the first real leaves, and at the same time the first small rootlets begin to reach down for moisture and plant food. Thus we have the tiny tree well under way and through its different agencies it continues to grow. All the terminal cells elongate until they divide forming new terminal cells, and this process, untiringly continued millions of times, gives height to the tree. At the same time the outside cells divide laterally so that new layers of cells are continually being added and thus the tree grows in width.

At intervals certain groups of cells form themselves into leaf buds which is another direct manifestation of the differentiation of tissues. As these develop into leaves and twigs, young new buds form at the points of union between the leaves and the twig and it is these buds, which develop the following year, that give to the tree its methods of branching. Those plants which do not have these buds formed at the axils of the leaves never have any branches but remain as straight stocks.

Roots, Trunk and Crown

The parts of a tree may be grouped into three classes, the roots, the trunk and the crown.

The roots serve two purposes. They hold the tree in place and procure moisture and mineral substance from the soil. They reach out in all directions and take a firm hold upon the soil, and it is very necessary that a large heavy trunk reaching far into the air is firmly anchored, or it will soon be pulled down by gravity and heavy gales.

These roots ramify through the soil in every direction repeatedly dividing and sub-dividing until almost every particle of soil beneath the tree has been pierced by the tiny hair rootlets. It is these minute threads that take up the moisture and mineral food by absorption, which as has been previously explained is the characteristic method of feeding the vegetable kingdom.

It is one of the laws of nature that all the soluble ingredients of a liquid tend to become distributed evenly throughout the liquid. Thus when the roots have utilized the soluble plant food from the moisture near them, other food is passed into their vicinity through the moisture in the soil. Generally, however, the roots obtain all the soil food they require from the moisture which they actually take up.

The principle of osmosis by which roots actually take in substances from the soil is very peculiar and extremely interesting. As a demonstration, solutions, such as molasses or salts may be confined in certain membranes through which they cannot pass even under pressure, and yet, if there is a liquid on the other side of the membrane the solution will readily pass through the membrane until the liquid on either side is equally rich in the solution. This action is called osmosis or dialysis and by this means the mineral foods of plants are passed into the roots. Osmosis also occurs constantly throughout other parts of the tree.

There is a peculiar relation existing between the roots of some trees and a certain low order of fungi called mycorhiza. The beeches, oaks, locusts, many of the conifers, and in fact most of the forest trees are assisted in their feeding by this tiny kind of plant life. The hair threads of the mycorhiza mycelium twine in and about the tips of the tree roots and procure the food which is passed into the tree. In such cases, the tree roots discard their own root hairs and depend upon the mycorhiza filaments to procure the food. The tree, in turn, furnishes sap and starch for the fungus. This fungus, though obtaining its food from the tree, cannot be classed as a parasite. It lives under a sort of contract relation with the tree. Each is of assistance to the other, and pays for what it obtains by rendering valuable service in return. The fungus has no chlorophyll, and in fact never sees the sunlight, so it obtains its starch and sap from the tree, and in turn it relieves the tree of the burden of obtaining nourishment from the soil. Thus, a mutual relation obtains between the two, which botanists call symbiosis. Probably, different kinds of mycorhiza associate themselves with different kinds of trees. Those trees whose roots are thickly enmeshed with mycorhiza must be handled with extreme care in transplanting, so that most of the smallest roots are retained with their mycorhiza and protected from drying. Otherwise, the trees will die from starvation after being moved.

Then there is a sort of mystery regarding the way moisture is carried to the top of a very tall tree. There are several principles of physics that undoubtedly help. Capillary attraction (that action which occurs when oil creeps up a lamp wick), plays an important part in raising the water in a tree. Some people also claim that the swaying of the branches pumps up the water. The rapid evaporation from the leaves may, moreover, tend to form a sort of vacuum in the ducts which would suck up water from below, and other ideas have been suggested; but all of these principles combined would not raise water three hundred feet to the top of some of the giant trees of California. This root force, whatever it may be, is enormous, as an astonishing amount of water is evaporated from the leaves of a large deciduuos tree every minute.

The cells of the leaves must be constantly supplied and distended with water or they will wilt, and a steady stream is constantly rising in a large tree on a hot day. Some idea of this amount may be gained from the fact that from one acre of hay on a hot summer day over one hundred tons of water is evaporated and about two hundred and fifty gallons from a large elm tree.

The trunk or bole of the tree supports the crown and supplies it with water and mineral food from the roots, as well as supplying the roots with digested nourishment from the crown. It is composed of outer bark, inner bark and wood. The inner bark or cambium is that film of growing tissue which completely envelopes the roots, trunk and branches of a tree and with the exception of the leaves and a few other tissues is the only part of the tree which is alive. That is to say, it is composed of live cells containing protoplasm and nucleii.

The cambium is composed of two layers. The outer layer forms cork cells which become the outer bark and serve as a protective covering. This stretches as the tree grows, and cracks, producing the rough effect, characteristic of many barks. The inner layer serves several important functions during the growing season, and then the protoplasm in the cells dies, the cell walls become thickened on the inner side with deposits of cellulose, and thus the tissue changes into wood. In this way a layer or ring of wood is added each year. Thus the entire inner or centre portion of the tree, which we call wood is merely composed of dead cells serving as a skeleton.

The crown of a tree is that upper part composed of branches, leaves, and fruiting bodies. Here the food which comes from the soil and air is digested and changed into vegetable matter. Here the reproduction is provided for, which, after all, is the most important part of tree life, as it provides for trees in the future. Here also come most of the hordes of enemies which war upon the health and beauty of the tree.

Certain mineral substances of the soil are required by the tree; but only in very small quantities. Of these mineral foods, nitrogen, phosphoric acid and potash are the most important.

Nitrogen tends to produce woody tissue. It is the most important and the most costly of all the foods. The air is composed of four fifths nitrogen, yet the plant is unable to obtain any of it. Certain plants of the leguminous family have nodules on their roots containing a certain kind of bacteria which have the power of obtaining this atmospheric nitrogen, and storing it away in the soil, so that the plant may obtain it. Most plants, however, are utterly unable to obtain nitrogen in this way and if there is not a sufficiency of nitrogen in the soil it should be applied as a fertilizer.

Phosphorus is an important constituent of protoplasm and it helps to ripen the fruit and wood; but only very small quantities are needed.

Potash is very necessary in the formation of starch. The actinic rays of sunlight act upon the potassium in the leaf in somewhat the same way as upon a photographic plate in a camera. This action is called photosynthesis. The active principle in the leaf which brings this about is the chlorophyll or green coloring matter. As starch and sugar form the bulk of most fruits, potash may be called a fruit producer.

This action of photosynthesis is one of the most vital processes in our world, for while it occurs in the vegetable kingdom, the animal kingdom absolutely depends upon it for its existence. Animals require proteids, carbo-hydrates and hydro-carbons. The carbo-hydrates or starches and sugars must be obtained from vegetable life where they are produced by the action of sunlight on chlorophyll. Moreover, the proteids or nitrogenous substances, and the hydro-carbons, or fats and oils, are all composed of nitrogen. Animals cannot take this in the mineral form from the soil, and depend upon plants to change

this nitrogen into a vegetable form, which could not be done without chlorophyll and photosynthesis.

The action of photosynthesis may be plainly demonstrated by actually taking pictures on leaves. During daylight starch is formed in the leaf and during the night this starch is transformed into sugar and made soluble. In the morning there is little or no starch in the leaf, and if a camera negative is placed upon a leaf at this time, when the sun shines down through the thin portions of the negative, starch will be formed. Then if the leaf is treated with solutions of iodide this starch becomes stained and the picture is produced and may be preserved in formalin.

In this process of starch formation the potassium is merely an agent. Starch is composed mostly of carbon. In fact, the great bulk of the tree—all that may be consumed by fire—is composed of carbon, and this is obtained from the air. In sunlight, the chlorophyll breaks up the carbonic acid gas, retaining the carbon and throwing off the oxygen. Then it combines the carbon with the hydrogen and oxygen of water, as well as with nitrogen and other materials from the soil, and this comprises the real food, which is dikested and sent in the form of sap to all parts of the tree, where it is further changed and used immediately or stored away to await future demands of the tree.

This taking of carbon from the air is called assimilation. Plants also have a real respiration or breathing. This occurs through pores in the leaves called stomata, and through lenticels in the bark. The stomata in the leaves may actually be opened and closed according to the needs of the tree. They are very small, however, and an average apple leaf has about 300,000 stomata on its under surface. The lenticels in the bark may be seen in some trees, such as the birch and cherry, where they show plainly as the little markings characteristic of those barks. Thus, while a tree is giving off oxygen as a by-product of carbonic acid gas, it is also taking on oxygen. This action also occurs in the roots, and one of the main reasons why city street trees are apt not to thrive is because the pavements exclude oxygen from the roots, although lack of moisture, also, is of course an important reason. The giving off of water from the bark and leaves is called transpiration.

In the autumn, most of the chlorophyll is drawn back into the twigs, before the leaves fall. We do not know just how this is accomplished, but a chemical breaking down occurs and the process may be watched. It seems to flow back from the margins of the leaves toward the ribs and then through the stem to the cambium of the twigs. If this process is overtaken by a drought the leaves fall prematurely, carrying some of the chlorophyll with them.

When a leaf is ready to fall, a layer of cork cells forms between the petiole and the twig. After that the leaf is virtually off the tree, and will fall at the slightest provocation. No more vegetable matter can flow back into the tree, but for a short time starch is still formed, and the leaf becomes very rich in several substances. Many pigments formerly hidden by the chlorophyll are now exposed, as well as deposits of nitrogen, iron, etc. All this produces the variety of colors which paint the autumn landscape.

There is very generally a wrong impression that the autumn coloring is due to frosts, but this is untrue. Frost may hasten the action, but trees color gloriously in the South where they have no frost. If the autumn is dry, the foliage becomes more brilliant than during a season with considerable rain.

The withdrawal of chlorophyll from the old leaves is valuable economy on the part of the tree. In this way an excess of chlorophyll becomes stored up in the cambium as a supply to the new leaves for the following spring. A young bud in early spring contains an embryo leaf ready for development, but how this can grow into a large leaf in a few warm days is an annual wonder and mystery to the casual observer. The reason lies with the stored up chlroophyll which

flows out from the cambium into the new young leaf, where, exposed to the sunshine, it takes up its elaborate work of producing carbo-hydrates.

Altogether the tree is a group of delicate cells, tissues and organs which form a complex and wonderful unit, composed of the elements, but possessing that marvelous and mysterious something which we call life.

COMMON TREES

This chapter does not attempt to furnish scientific descriptions or classified information.

Before making the choice of trees for planting, something should be known of the requirements, the desirability, and the interesting features of the different trees. Such information will prove a helpful guide in making selections.

Most people have no time or inclination to deeply study the subject, and wade through descriptions filled with unfamiliar botanical terms. For the benefit of such persons we have here briefly considered the common trees, and we hope that in some readers an interest will be aroused which will lead to a deeper study and a genuine interest and love for beautiful trees.

OAK

The oak is an emblem of sturdiness. Every line shows character, stability and strength. It is monarch of the wild wood and even more beautiful in the open. Though generally considered to be of slow growth, this characteristic is not usually true. The white oak grows slowly, but the black oak, the swamp white oak, the pin oak, and the red oak grow rapidly when young.

Someone has said that trees may taste of immortality. Certainly, trees never die of old age. If diseases could be controlled, trees would live forever, and the oaks are able to stand battle for centuries. Some are known to be over a thousand years old, and it is claimed that trees are now standing under which Virgil sat and wrote; but this may scarcely be credited.

Most oaks require at least 100 years to mature, and acorns are seldom borne before the 20th year. The flowers being diminutive are seldom noticed, nevertheless they are beautiful and should be appreciated. The autumn tints of the foliage are glorious, and in every way these trees are desirable and valuable in landscape work, and they should be planted more frequently in this country. Landscape gardeners fully appreciate this fact and act accordingly.

The oaks are divided into two groups. Those of the white oak group have rounded lobed leaves and blossom in the spring, bearing acorns the same year. Thus they are annuals. Those of the red oak group have pointed lobed leaves and their acorns are not ripe until the autumn of the year following that in which they flower. Therefore, they are true biennials. There are 300 different varieties of oaks and fifty of them are found in North America. Most of the oaks readily hybridize so that we are often confused as to their names, but certain of the more common varieties have very characteristic markings by which they may be easily distinguished.

WHITE OAK.

Quercus alba.

This tree receives its name from the color of its bark, which is gray or grayish white, and broken into rough scales. It is generally a tall tree and makes a tremendous round-topped head. The leaves are long and round pointed. In the autumn they turn a rich, purple red. Because of its value as a timber tree the white oak is fast disappearing. It will grow on most any good soil.

SWAMP WHITE OAK.

Quercus plantanoides.

The swamp white oak branches very near the ground, and the bark is more deeply fissured than that of the white oak. Especially on its branches, the old

bark peels away, and altogether this tree is straggly and careless of its appearance. It loves the swamps and low, wet lands. The young leaves are greenish bronze, and in the autumn the old leaves turn dull yellow, showing no markings of red.

CHESTNUT OAK.

Quercus prinus.

This has a very rough bark with something of the hobbly appearance of tupelo bark. The serration of its leaves is not unsimilar to that of chestnut leaves. The chestnut oak is generally found on high land and rocky hillsides, but it also does well in low, wet soils. It is not a particularly beautiful tree and is of very slow growth and unimportant for timber.

RED OAK.

Quercus rubra.

The bark of the red oak is dark and somewhat smooth in appearance. The old bark is more or less roughened with broad ridges, but these have smooth areas between them, and the young bark is distinctly smooth. The tree forms a beautiful rounded head and is very stately. The leaves may be either broad or narrow, but the end of each lobe is sharply pointed. When very young, they are pinkish and downy. In the fall, they become dark red or russet, and remain on the tree until late in the winter. The acorns are very large. The red oak will thrive on a variety of soils, and grows quite as rapidly as most of our native trees. It is an excellent tree for planting.

BLACK OAK.

Quercus velutina.

The outer bark of the black oak is dark and very rough, even on young trees, but the inner bark is bright yellow. The leaves are deeply cut and the lobes narrow with sharp ends. In the early spring they are crimson and downy, and in the autumn they are brown or dull red, sometimes showing yellow. The leaves remain on the trees very late, many of them until spring, when they are forced off by the new buds. This is more or less true of all the red oak group.

SCARLET OAK.

Quercus coccinea.

This tree is more upright than the other oaks, and prefers dry, sandy soil. Its bark is less even than that of the red oak, but not so rough as that of the black oak. The outer bark is dark brown and the inner bark is reddish gray. The scarlet oak receives its name from the brilliancy of its coloring in the autumn. The flowers also are somewhat scarlet. It is beautiful at all seasons and a favorite ornamental tree.

PIN OAK.

Quercus palustris.

This is a high tree forming a straight, upright leader. The branches are close and regularly arranged, but fine, so that they escape being ungraceful. The small twigs somewhat resemble pins, although this comparison requires considerable imagination. The most striking characteristic of the tree is the very noticeable drooping of its lower branches. For this reason, although very beautiful for lawn planting, it is not desirable for city streets. When old, the lower branches die, and then the tree is not so graceful as when young. In winter the buds of the pin oak are very small. The leaves also are small and deeply cut with sharply pointed lobes. In the autumn they turn deep scarlet. The root system is deep when standing in dry soils, but it needs low, moist land with rich earth for its best development. The pin oak is one of the most desirable trees for lawn and park planting.

BEECH

Fagus atropunicea.

Among our American trees, the beech holds a place of its own. It may well be called elegant. With its closely fitting bark and carefully arranged leaves and twigs, it is very dressy and well groomed. Clean and dainty in winter, rich and beautifully clad in its finely woven foliage in summer, and carefully retaining its delicate pale yellow leaves in the late fall, it is very genteel and attractive in every season. Everyone is fond of the beech for its neat, ladylike grace, and it truly seems impossible for lovers to pass a beech without leaving their initials carved upon the trunk, although such thoughtless marring is to be deplored. The trunk appears to be corded, and the bark resembles the skin of an athlete tightly drawn over powerful muscles. The Indians firmly believed the beech was a safe refuge from lightning, and they were correct. Owing to the oils or fats which are contained in the tree, lightning is repelled. This is also more or less true of the chestnut, linden, and birch. The red or copper beech is not a separate variety from the green leaved beech. The difference seems to be in the color alone. When young, beeches are tolerant of shade, and they make an excellent forest undergrowth, but later demand light, and often crowd out the other trees so that a clear stand of beech prevails. In order to produce its most perfect type, plenty of room should be allowed for development. The beech needs a well drained soil, but it thrives both on highlands and in rich lowlands, and does especially well on limestone soils.

CHESTNUT.

Castanea dentata.

The chestnut tree is a general favorite, both for the tree itself and also because of its fruit. It does not blossom until midsummer, after the fruit of many trees has come and gone. The shade is unusually deep because of the richness of its foliage, and the wood is valuable. The tree grows rapidly and lives to a great age, some fine specimens being known to have lived over 1,000 years. The famous Chestnut of a Hundred Horsemen on Mt. Ætna in Sicily is over 60 feet in diameter at the base and has a road passing through it. In this country the chestnut has recently been attacked by a fungous disease which works under the bark so that it cannot be controlled, and we are obliged to remain helpless and watch grand old veterans die before our eyes. It looks as though the American chestnuts were doomed, and in a very few years they may be a thing of the past.

WHITE ASH.

Fraxinus Americana.

The white ash is an excellent tree for city planting, owing to its tremendous root system, which permits it to thrive in dry places. It will, however, do well in moist soils, and sometimes swamps may be drained by planting ash trees because the roots are able to extract such large amounts of water. This tree is devoid of delicate twigs and is therefore stiff and lacking in grace during the winter. In summer, however, it is beautiful, as the leaves are compound and gracefully clothe the rugged limbs. The ash is a member of the olive family. The wood is light and strong, and, like the oak, it is often struck by lightning. It is also said that snakes will not come to the vicinity of an ash tree. Its autumn coloring is rich in bronze, chocolate and yellow, but never in crimson and scarlet.

RED ASH.

Fraxinus pennsylvanica.

This tree is usually low, seldom growing over fifty feet in height. The trunk and limbs are thick set and sturdy. In general appearance it is similar

to the white ash, but the bark is dark and the leaves are less serrate, having a wavy rather than a notched outline. The leaves and branches are sometimes downy, but not always.

MAPLE

One of the most widely distributed of our native trees is the maple. It is a valuable forest tree and enjoys both shade and light, which is the reason for its abundance. All the varieties are rapid growers, which fact makes them valuable for planting, and in the autumn, the splendor of their foliage does much toward making the landscape radiant. The maples probably came originally from Japan.

SUGAR MAPLE

Acer saccharum.

Most of our maple sugar comes from the sugar maple or rock maple. The removal of sap does not injure the trees. Some maples have given sap for over a century and are still in their prime. The sugar maple is an unusually fine tree for avenue planting. In the autumn it is rich with yellow and reddish orange coloring. The buds in winter are very sharply pointed. The old bark has curling ridges somewhat resembling the broken furrows of a plow-share, but not arranged regularly. The beautiful bird's-eye maple wood appears in all the maples. There are no definite outward markings to show that these trees have the peculiar curly grain, although some expert treesmen can generally recognize such trees while they are growing. Probably the bird's-eye effect is due to dormant buds which remain alive long enough to establish a grain in the wood, although it may be due merely to physiological conditions.

RED MAPLE.

Acer rubrum.

This variety loves the swamps. In many places it is not as beautiful as the sugar maple and it is not generally as satisfactory for street planting. For coloring, however, the red maple excels all others. At the end of winter the garnet buds shine out like tiny eyes. In the spring the young leaves are red, and the red wings of the keys swing on graceful stems. Early in September, the trees become glowing masses of flame, and their gorgeous beauty may be seen for miles. The leaves of the red maple vary greatly, either on two neighboring trees or on the same tree. They may be large or small, thick or thin, three lobed or five lobed.

SILVER MAPLE.

Acer saccharinum.

These also prefer low ground and love the banks of quiet streams deep in the solitude of the woods, being not frequently found near towns and cities except under cultivation. They can also thrive on dry soil, but should not be planted on high ground. With their shaggy bark and deeply cut leaves, the silver maples are graceful and attractive as well as being rapid growers, but they are not good trees to select for planting, as the branches are not strongly attached to the trees and the wood is very easily broken by winds and ice storms. Moreover, the trees are very subject to borers, especially when planted on city streets where moisture is lacking. One particularly beautiful and fast growing variety, which may be planted in moist soils when a quick effect is desired, is known as Wier's Cut-Leaf Maple.

NORWAY MAPLE.

Acer platanoides.

The Norway maple is an imported tree. It has a very deep root system which renders it especially appropriate for city planting. The leaves are dark green and form a beautiful contrast against the very dark, closely knit bark. This tree may be easily distinguished by the white, milky sap which exudes from

the petioles or leaf stems when they are broken. One of the Norway maples, called the Swerdler Maple, has leaves of a rich, reddish bronze color in the spring.

SYCAMORE MAPLE.

Acer pseudo-platanus.

This is one of the most beautiful of the European maples. It is characterized in winter by its very green buds. The bark loosens and falls in thin, square flakes. The leaves of the sycamore maple are similar to those of the Norway maple, but they have larger lobes and often slightly resemble the leaves of the grape vine.

BOX ELDER OR ASH-LEAVED MAPLE.

Acer negundo.

Strange to say, this maple has compound leaves, and if it were not for the keys or winged seeds, we should never recognize the species. When young, it sometimes forks near the ground, in which case it greatly resembles the peach tree in its method of branchin. The leaves are similar to those of the ash, and when old the bark somewhat resembles that of the ash. Altogether it is an odd and attractive variety, but like the linden it is a dirty tree and continually covers the ground with debris. It is hardy, however, and makes a very rapid growth, and is very plentiful in the prairie states.

MOOSEWOOD OR STRIPED MAPLE.

Liriodendron tulipifera.

This small, shade loving tree is especially attractive in winter when the striped green and white of its bark is brought into prominence. The leaves have a peculiar shape, being broadest at the outer ends.

LIRIODENDRON OR TULIP TREE.

Liriodendron tulipifera.

The Liriodendron is one of the most beautiful of our native trees. It prefers deep, rich and rather moist soil, and grows fairly rapidly. It is a solitary tree and symmetrical. Tulips have been known to grow nearly two hundred feet in height, probably ninety feet is about the average. This is the tree that furnishes the white wood so much used in carving. In the early settlement days, when tulip wood was plentiful, it was much used for construction, and in some of the older rural communities such as Sharon, Conn., nearly every one of the olden time houses was built largely of tulip wood and many of them may be seen to this day. The flowers of the liriodendron closely resemble tulips, and even the outline of the leaves is suggestive of the profile of tulips. This tree belongs to the magnolia family.

SWAMP MAGNOLIA.

Magnolia glauca.

We must speak of another member of the same family to which the Liriodendron belongs. The Swamp Magnolia ranks with the finest of our native trees. It is a southern species, but strange to say, it is found growing naturally in a sheltered swamp on Cape Ann, near Gloucester, Massachusetts, although the leaves are not evergreen there. It can be grown in other moist and sheltered places in the north.

LINDEN.

Tilia europaea.
Tilia americana.

There are several kinds of lindens but the two best known are the American Linden or Basswood, and the European Linden, known in England as the Lime Tree. The lindens are excellent trees for planting in positions where they will have room for development. They are quick of growth and will

stand severe pruning. Their foliage is abundant producing a very deep shade, and the branches droop very gracefully. The blossoms are favorite with bees and furnish extra fine honey The wood is soft and similar to that of the tulip and is often wrongly called white wood. Some lindens are known to be over 1000 years old.

CANOE BIRCH OR PAPER BIRCH.

Betula papyrifera.

Many gardeners envy the birches the space they occupy, but no greater mistake can be made. With their light, airy foliage and white bark they render a delightful and refreshing contrast against a background of darker trees. Birches are rapid growers and short lived, but very showy and we are indebted to Nature for them. The wood quickly decays if exposed to the weather, but the bark is almost imperishable even when buried in the soil. Birch wood is beautiful indeed when stained and polished. It so closely resembles mahogany that the fact gives rise to much fraud in manufacturing, and its actual value as a beautiful wood should be fully recognized. It is the delight of children to strip the bark from Canoe Birches, but this renders the trees unsightly, and especially with specimen trees this stripping should never be permitted. To the woodsman, however, birch bark is very valuable for making many useful implements of woodcraft. The outer bark is creamy white and very attractive. These trees are best suited to rich, moist soil on hillsides.

GRAY BIRCH.

Betula populifolia.

This has a grayish white bark which never peels off as does the bark of the Canoe birch. It also lacks the snowy whiteness of the latter. It may be easily distinguished by the triangular black markings under the branches. The leaves somewhat resemble those of the poplar, trembling in the slightest breeze as do the Asepn leaves. The Gray Birch thrives in the dry barren soil of old fields or rocky woods. It plays an important part in reforestation, by springing up where other trees cannot start, thus preparing the soil, and furnishing a shade for the seedlings of more valuable trees.

BLACK BIRCH OR MAHOGANY BIRCH.

Betula lenta.

This is often called the Sweet Birch. The bark resembles that of the cherry. It is tall with a full head and very beautiful. When old, its bark cracks away from the trunk, but never peels. Its bark is nearly black and very aromatic. In the woods the Black Birch is most often found near mountain brooks.

YELLOW BIRCH.

Betula lutea.

Though ragged, the Yellow Birch is not uncomely. In fact, a good specimen of this tree will itself beautify a landscape picture. It has a sturdy trunk and is tall and stately with a broad round topped head and branches somewhat drooping. The outer bark is silvery, but this has a habit of peeling back into little curls revealing the richness of its golden undergarment. Like the other birches, it seeks moisture and does best on rich uplands.

RED BIRCH OR RIVER BIRCH.

Betula nigra.

The Red Birch has a very shaggy and flaky appearance, owing to the looseness of its red bark which tears itself away from the trunk. This tree not only overhangs the water, but actually wades into the streams, and the graceful sweep of its drooping branches lends beauty to any woodland picture.

WHITE BIRCH.

Betula alba.

This is a European tree often cultivated in this country. It has an erect leader and a singularly regular method of branching, especially for a birch.

The tree lifts its high, even head well into the air, but so delicate is the tracery of its slender drooping branches swaying pliantly in the faintest breeze that the effect is one of perfect grace and rare beauty. The bark at the ground is dark and roughened, but higher up it becomes smooth and clear, showing varying tints of white and silver accentuated by occasional markings of black.

IRONWOOD OR HOP HORNBEAM.

Ostrya virginia.

The Ironwood is a small tree of slender growth. It is a member of the birch family, and its leaves resemble those of the birch. The clusters of its yellow-tinted fruit are attractive. The bark is finely furrowed and slightly shaggy. The wood is especially strong and its provincial name, Leverwood, is appropriate. The Ironwood is a solitary tree and rare in the forests, generally growing on dry hillsides. It does well under cultivation, but should be protected by some shade.

HORNBEAM OR BLUE BEECH.

Carpinus caroliniana.

In many localities the Hornbeam is very prevalent as an undergrowth of forests. Like its cousin, the Ironwood, it is a member of the birch family. It grows very slowly and never becomes a large tree. Under cultivation it does well if planted in deep, moist soil; but the topping which is practiced on many trees at the time of transplanting should never be done on the Hornbeam, or its charcateristic method of growth will be destroyed. The bark is smooth, bluish gray, and generally uneven as if growing over smoothly rounded elevations in the wood.

BLACK WALNUT.

Juglans nigra.

Few trees are more grand than the Walnut. In rich soil with plenty of room for development, it makes a magnificent growth. With lower branches sweeping the ground and its upper ones reaching far aloft, the effect is fine and stately, and the foliage catches the sunlight in such a way that the result is a beautiful, golden glow. The leaves come out late in the spring and go early in the fall, but the summer effect is delightful. This tree has a deep root system and does not frequently suffer from drought, but it grows slowly. In the forests, it produces a different tpe, struggling straight upward with a small head and no branches below. Many leaf eating insects attack the foliage, and for this reason the tree requires attention when cultivated.

BUTTERNUT OR WHITE WALNUT.

Juglans cinerea.

The Butternut is generally low, broad and unsymmetrical. Closely resembling the Black Walnut in many ways, it falls far short of it in regard to beauty, often becoming misshapen, and for this reason it is more appropriate in wild and unconventional places than for street and park planting. It will grow on hills if the soil is fertile, but does best on moist lowlands. Its deep roots protect it against sudden droughts and sometimes it is a desirable tree in private estates when rough, ragged effects are desired.

SHAGBARK HICKORY.

Hicoria ovata.

The Hickories belong to the Walnut family and closely resemble them. The Shagbark Hickory is easily recognized by its loose bark which separates from the tree in long strips. Though willing to grow in constricted quarters, the Shagbark or Shellbark is most beautiful when permitted to develop a full, rounded head. It is especially beautiful in winter when its branches are very

black and grotesque in their method of spreading. The wood is valuable, being light, pliable and very tough. All the Hickories are distinctly native trees not being found in other countries. They possess dignity and beauty. Owing to a very large tap root, they are transplanted with some difficulty, and do best on deep soil which is rich and rather moist.

PIGNUT.

Hicoria glabra.

While this name may be suitable to the fruit, it is unworthy of the tree, as the Pignut is beautiful and attractive. It is a tall tree even in the open, and when crowded by its neighbors, it serves an admirable illustration of the struggle for existence, climbing far aloft for sunlight. The bark clings closely and is covered with fine, curling fissures, and the tree has a peculiarly clean appearance. The compound leaves usually have fewer leaflets than those of the Shagbark. It is suited to the same soils.

SASSAFRAS.

Sassafras sassafras.

This is an interesting tree because of its differently shaped leaves. Like the Mulberry, its leaves have a varying number of lobes or even no lobes, and these different kinds are found intermingled on the same branch or even on the same twig. The Sassafras grows rapidly and in most any soil, but does best in rich earth which contains sufficient sand to keep it well drained. The bark is roughly furrowed and the tree is more picturesque than beautiful. New trees are formed by sprouts so easily that a thicket is generally produced about the parent. All the tissues of the tree are aromatic, and birds are especially fond of the berries. The Sassafras may be easily distinguished in winter by the green bark of its smaller branches and twigs.

MULBERRY.

Morus rubra.
Morus alba.
Morus nigra.

There are three varieties of the mulberry, the red mulberry, the white mulberry, and the black mulberry. Each receives its name from the color of the fruit. The mulberry is an interesting tree and is often recommended because of its rapid growth, but the leaves come late in the spring and the tree is ragged and unattractive in winter. The fruit of the black mulberry is delicious, and this tree may be planted if for no other reason. The white mulberry is the favorite food of silk worms, and is a native of China, where it has been reared for this purpose during thousands of years. Like the sassafras, the mulberry bears leaves of three different forms on the same branch, some being heart shaped, others having one lobe, while still others have two or even three lobes. The bark is reddish brown and very rough. The trunk is short and the branches are numerous, often producing a bushy effect. The mulberry grows rapidly, especially in rich soil.

SYCAMORE OR PLANE TREE OR BUTTONWOOD.

Platanus occidentalis.

A fine old sycamore or buttonwood is very striking. The branches are rugged and somewhat stiff in appearance, but very picturesque. The mottled appearance of the branches and frequently the trunk is due to the fact that the tree sheds its bark as well as its leaves. The sycamore has great vigor and the leaves are large and broad, but in many parts of the country a fungous disease attacks and destroys the first leaves before they are fully grown, and in early June a second foliage is produced. We are unable to control this fungus, and, unless Mother Nature does so in the near future, the trees will eventually disappear. Many people do not care for the sycamore, but in our opinion it is a

very attractive tree when at its best. It grows to a great height, sometimes dividing at the ground into several huge trunks. The mottled bark is valuable to the winter landscape. This tree prefers low, rich soil.

POPLAR.

Populus deltoides.
Populus nigra italica.

The poplars are generally used for immediate effect. Several of the varieties are real ornaments under good conditions, and the cottonwood or Carolina poplar often makes an attractive tree in a short space of time. Moreover, its leaves keep clean and free of soot, which makes it valuable for street planting in dirty cities. The Lombardy poplar was formerly a favorite, but is now little used. It forms a spire-like head, and, if properly placed, may give character to a landscape, but the tree is coarse, having an excess of branches which grow upright following the line of the trunk. The lower branches quickly die and remain upon the tree. Lombardy poplars are sometimes used as a screen. In such cases several rows should be planted rather than a single row. They grow very rapidly, but soon become ragged and unsightly and more like tall weeds than trees. As forest trees, poplars were formerly considered of very little value, but now they are grown commercially on a large scale to supply those hungry demons, the paper pulp mills.

LOCUST.

Robinia pseudacacia.

The locust is a tree well worthy of attention. While not particularly attractive in winter, it is delightful in summer, possessing a light, airy and lofty grace which is charming. The blossoms are fragrant and the leaves are always green and free of dust. In wet weather and at night the leaves fold together, a general characteristic of the entire leguminous or pea family. Unfortunately, the locusts are very subject to borers, and in many communities the trees are never able to produce attractive specimens, but become ragged and unsightly. There seems to be no practical way of controlling this insect. The Kentucky coffee tree is often confused with the locust, but there is a marked difference. Like the Hercules club and the honey locust, the leaves of the Kentucky coffee tree are doubly compound, often three feet long and two feet broad, while the regular locust leaf is only singly compound. The Kentucky coffee tree has no thorns whatever. The honey locust has large thorns which arise from the wood. The Hercules club and the common locust both have small spines, but these are merely in the bark and do not originate in the wood, and cannot be considered as true thorns. The Hercules club, which is rare but unattractive, is not of the locust family.

YELLOW-WOOD OR VIRGILIA.

Cladrastis lutea.

Though not well known in the eastern states, the yellow-wood is a beautiful ornamental tree and should be grown more frequently. The bark is smooth and greenish gray in color. The leaves are compound with smooth, oval leaflets, and in the autumn they are rich yellow. In June the tree is heavy with masses of white, drooping flower clusters. The yellow-wood prefers rich, moist soil and grows rapidly. The trunk generally divides near the ground.

HORSE CHESTNUT.

Aesculus glabra.

This tree is not beautiful in winter, the stiff twigs and large terminal buds being too evenly arranged. It does not grow wild in our northern states and has a hard time even under cultivation. Many people are especially fond of the horse chestnut. The flowers and leaves are beautiful in the spring, but in most localities the leaves are liable to the attack of a fungus which turns them brown and causes them to fall early in the summer. The horse chestnut is a solitary tree like the tulip, the elm, the willow, and the sycamore. The Ohio buckeye is

a variety of this species and is so named because the brown scar on the nut resembles the eye of a deer. This is also somewhat true of the horse chestnut. The buckeye is a native, while the horse chestnut is European. If planted, the horse chestnut should be given good soil with plenty of moisture, as the tree quickly suffers in cases of drought.

WITCH HAZEL.

Hamamelis virginiana.

Who has walked the woods in October, when Mother Nature was preparing the trees and shrubs for their winter sleep, without experiencing the surprise and pleasure of finding the witch hazel in full blossom? One might think this little tree very courageous to put forth its flowers in defiance of the signals of winter, but in truth it is a laggard, and not only are its blossoms tardy, but the fruit is not borne until the following year. Thus it happens that the fruit and flowers are both on the tree at the same time, just as with the orange. When ripe, the seeds are discharged from their pods with considerable force, and carried several feet, as if glad to be freed from the tree at last. The witch hazel hardly deserves to be called a tree. It is rather a shrub, and loves the shade of taller trees. The leaves are oval and have a peculiar serration by which the tree may be easily distinguished after one has become familiar with it.

LIQUIDAMBER, OR SWEET GUM.

Liquidamber styraciflua.

This tree with its starry, five-pointed leaves is to the South what the maple is to the north. It reaches as far north as southern Connecticut, and the autumnal coloring is superb, actually glowing with red, yellow and purple. The liquidamber has very characteristic corky ridges on the bark of its branches and twigs. It produces a large, erect trunk with somewhat slender branches. This tree should be planted more freely, and prefers low, moist soil, but will adapt itself to high, dry land.

FLOWERING DOGWOOD.

Cornus florida.

This is the most attractive of the dogwoods. It is a low, bushy, shade loving tree with a flat head. In the spring it is covered with blossoms before the leaves come out, and the mass of snowy petals is one of the characteristic sights of the woodland scenery at that season. Later, its scarlet berries and dark red leaves do much to make the autumn brilliant. It prefers dry soil.

TUPELO OR PEPPERIDGE OR SOUR GUM.

Nyssa sylvatica.

The tupelo is even more gorgeous in the autumn than the sweet gum. In fact, it leads all of the gaudy group such as the dogwood, sassafras and maple in the brilliancy of its coloring. It prefers low, wet lands, and requires shelter for its best development. When a large, old tupelo is found standing in the open, the top is generally dead or broken completely off; but if surrounded by neighboring trees, it develops into a beautiful specimen. This tree is being planted more than formerly. It has a deep root system and is not easily injured by dry weather. The leaves are oval, dark green and shiny. The branches are fine and graceful.

CATALPA.

Catalpa catalpa.
Catalpa speciosa.

One of our native trees which was formerly little known but is now becoming a favorite, is the catalpa or Indian bean. With its short, stocy trunk and fantastically spreading arms, it produces a very picturesque effect. Its flowers are very showy like those of the horse chestnut, which they slightly resemble, but they are whiter and more drooping than the horse chestnut flowers. The large, heart-shaped leaves are very graceful and enjoy the peculiarity of secreting nectar. This tree does best when standing in moist soil and protected by a partial

shade. It grows very rapidly and the wood is valuable for timber. The variety C. speciosa is practically the same as the C. catalpa.

AILANTHUS.

Ailanthus glandulosa.

Many people consider that the ailanthus ought never to be planted. It is a coarse tree and quickly becomes hollow at the base, but it has many virtues nevertheless. It grows very rapidly even on dry and barren soil, and will produce a quick effect. Moreover, the large compound leaves retain their bright green color late in the summer. The staminate flowers give off a very offensive odor, but nurserymen can furnish pistillate trees.

HOLLY.

Ilex opaca.

The holly is an evergreen like the rhododendron, and does well from southern New England to the Gulf states. It will thrive on dry or wet soil, but grows very slowly. It is a beautiful tree with its shining, spiny leaves, and its clusters of white flowers or scarlet berries, and it should be more frequently planted. Owners of woodlands where it grows should not allow excessive stripping of the holly branches by seekers of Christmas green, or it will disappear owing to its slow growth. The holly should be transplanted in the spring before the dormant season is over, and all the leaves should be removed from the trees or they will die. This removing of the leaves at the time of planting is often done with other trees when it is a mistake, but with the holly it is necessary.

AMERICAN ELM.

Ulmus americana.

None of our trees are more striking than the tall and stately American elm. It shows a strength of limb and delicacy of twig which produces a very delightful combination, and even in winter, when stripped of its foliage, it is beautiful and attractive. The graceful outward curve of the bold, rugged branches is very effective when long rows of elms are planted on both sides of a road, the result being a continual Gothic arch outlined by the limbs. The blossoms come early in the spring and are generally passed unnoticed. The leaves frequently suffer severe damage from the elm leaf beetle, but this may be easily controlled by spraying. This tree grows rapidly, especially in rich, well drained, alluvial soil, and is long lived. American elms are especially developed in New England because they have been growing there so many years, and the soil is specially congenial; but these trees will make a beautiful growth in most of the eastern states, and in the middle west also they will become grand, old specimens when they have attained sufficient age to permit it.

ENGLISH ELM.

Ulmus campestris.

While possessing great beauty, the English elm has a different growth from the variety which is native to this country. One straight leader is formed from which the branches are given off. The English elm is as rugged and stocky as the American elm is graceful. The foliage arranges itself in beautiful masses and remains green and rich until late in the fall.

WHITE PINE.

Pinus strobus.

Of the many varieties of pines, and in fact, of all the evergreens, the white pine stands out with a sort of kingly dignity. It assumes a variety of shapes according to its environment, and frequently it is picturesque, but unless mutilated, it is always beautiful. He who has stood in the depths of a real pine forest, drinking in the fragrance of its breath, listening to the whispered songs of the cathedral woods, and experiencing the stateliness and solemn grandeur of Nature's temple, has found the pine in its true home and has brought away with

him a broader mind and a richer soul. Of all the timber trees, the white pine is the most sought by lumbermen. Fortunately, it will thrive on most soils, and formerly our continent was covered with vast areas of pine, but the absurd methods of wasteful and destructive lumbering have nearly exhausted the supply. It is a rapid grower, even on sandy soils. The leaves, or needles, are in clusters of five. The bark is smooth except on the old trunk.

RED PINE.

Pinus resinosa.

The red pine, also, is very beautiful. It is a solitary tree and never occurs abundantly in the forest. In the open, however, it makes a splendid growth, tall and erect and with plenty of low branches. The leaves appear in clusters of two, and are set in deep sheaths by which the tree may be recognized. The scars of these sheaths make the bark rough and scaly more like the bark of the pitch pine; but the red pine need never be confused with the pitch pine, as the latter is smaller and extremely coarse, and its leaves are in clusters of three. The red pine should be planted freely, but never in clay soils. Sunlight and dry, coarse soil are very necessary.

SPRUCE.

The spruces are most characteristic when permitted room for development. Tall and straight, with their branches curving downward and outward, they stand like melancholy sentinels vainly endeavoring to lift their arms. The red spruce, the white spruce, and the black spruce are native to America, and they are distinctly northern trees, true Arctic explorers, in fact. The Norway spruce is European, and is the most important growth of the Alpine forests. It flourishes in this country, and is a beautiful tree for American planting.

HEMLOCK.

Tsuga canadensis.

The hemlock is a valuable tree for aesthetic planting, especially on steep and rocky slopes. It is not an important timber tree, as the wood has little value, but the bark is much sought on account of its tannin, which is used in leather manufacturing. The bark is very rough and the leaves are short and flat. Like the spruce, the hemlock allows its branches to droop and sweep the ground, but in a much more graceful manner. The spray is flat, but filmy and lace-like.

PLANTING

What to Plant and Where

Whenever it is found that a street or vicinity or an estate is in need of trees the questions at once present themselves as to just where the trees should be placed, what trees are most desirable for the different locations and how they should be planted. Each of these subjects is worthy of cosiderable attention and this is demanded if good results are to be gained.

We are in the age of specialization and it is always best to call in a special landscape gardener if possible. Landscape art, the art of outdoor life, requires study and experience as well as natural talent if perfection is to be obtained. Many people wish the pleasure of undertaking all such work themselves, but even then it is most wise to follow a working plan of some good artist. If this is impossible, we should proceed with care in order that we may not offend by disregarding the laws of landscape art and the laws of nature.

Whenever the need of a tree is felt we must first acknowledge the purpose for which it is needed, and then decide what tree will best accomplish the desired result and in making such a decision the tree has something to say about it. We must not plant our favorite variety in a certain place unless the conditions and environment are suitable. A tree that is beautiful at one location may not thrive in another, and a poor specimen in wretched health is never an ornament.

And then the laws of propriety and good taste must be considered. What may be suitable in one place, may not be at all satisfactory in another.

It would not be good taste for an architect to construct the walls, ceilings and exterior of a simple colonial house according to the lines and embellishments which might be used for a Venetian palace, nor for the drawing room of the same Colonial house to receive the same appointments which would be appropriate in the more extravagant abode. Again it is not good taste to set a typical Fifth Avenue residence off by itself in the woods and fields to serve as a country home, although this is often attempted.

In just the same way, to a considerable extent, we must use care in planting. To be sure, Nature is very capable of adapting herself harmoniously to most conditions, and a beautiful tree is beautiful wherever located; yet by following the laws and good taste of fine landscape art we may so arrange our planting that the best results are accomplished.

We must consider the entire picture as a unit, and after designing, as it were, the desired effect in our mind's eye we should choose each tree and group of trees for each part of the picture so they will in very case lend their portion of the desired result to the composite landscape.

There is the skyline to be produced, high at this point, low at that, full and rounding there, and sharply pointed and broken at another place. The skyline must be considered from different standpoints. A large rounded elm might give character to the horizon from one point of observation and yet shut off a delightful view which is very essential from another position.

Certain groups of rocks might be beautifully clothed with a judicious planting of evergreens; when the same evergreens at another place would not harmonize with the surrounding deciduous trees.

Small cedars or ground junipers may be scattered over the slope of a broad hillside field when large deciduous trees would break up the field and produce an inferior effect.

Around the margins and grouped at the corners of the same field, large broad-leaved trees might serve admirably, and even at one or more points within the field, deciduous trees could be grouped into dense islands of foliage in a pleasing manner.

Willows that would droop artistically over a brook, or mass themselves upon a point of land protruding into a pond or lake, might be very unsatisfactory as specimen trees with different surroundings.

Birches, growing in a row along some drive might lack character; but the same trees, with their snowy bark and graceful heads, if daintily grouped in a natural way set off by a background of darker green would lend much character.

One Lombardy poplar or several in a group are often desirable, while a row of them along a walk in the midst of other less conventional trees is very unsatisfactory.

A clump of ragged locusts with their wild picturesqueness is very pleasing in most places; but for the immediate vicinity of a large formal house they would not be sufficiently dressy.

We must also consider the natural habitat of trees, and in planting give preference to those which will do best with the climate topography, locality, and soil in question. The American elm, for instance, is capable of most beautiful development in fairly moist soil containing a plentiful supply of silt, some clay, and enough fine sand to permit good drainage. It wil lalso thrive in moist places but does not prefer a dry soil.

White oaks, red oaks, scarlet oaks, birches and maples do best on fairly dry soil.

The white pine does well on most any soil that contains any reasonable amount of nourishment, and the ailanthus will thrive in the most barren places.

Red maples, swamp white oaks, pin oaks and sycamores like low and more or less damp locations for their best development.

Chestnuts prefer medium high land with plenty of clay; and the hemlocks, rock maples and some of the hickories love to climb among steep, rocky hillsides.

Trees are not restricted to their natural habitat but when planted in other places they are more or less subject to drought, winterkilling and insect troubles.

Where groups are desired, we must use those trees which will stand grouping. Many trees which will spread out into broad full specimens if permitted room for development are able to get along with less room if necessary, struggling up to a greater height and producing a different type, but still beautiful. The hickories are good examples of such adaptable trees. On the other hand, the elms, oaks, maples, and beeches should not be crowded as they are not as beautiful in a wild ragged condition as when allowed plenty of room for perfect development.

When planting closely to produce dense effects, it is well to use an undergrowth of shade loving trees. For this purpose the dogwood, hornbeam, alder, birch, striped maple, mountain ash, iron wood, sassafras, tupelo and witch-hazel serve admirably, being more or less tolerant of shade.

Of the large trees, even those which stand grouping and, therefore, more or less lateral shade, have a tendency to lose their lower branches, partly because of lack of light and partly because trees naturally prune themselves when close. Thus, when growing in dense groups, all trees have a tendency to become spindly and bare of lower branches, and the undergrowth of small tolerant trees will act as a filler and produce a low mass of foliage.

In planting we must not neglect the winter effect, for when all the deciduous trees are stripped of their foliage, those which are attractive because of colored barks, such as the beeches, dogwoods, birches and sycamores, give life and warmth to the landscape, relieving the somber browns and snowy whites of winter. Of course, the evergreens play a very important part in a winter picture.

In road-side planting and the planting along city streets, special care should be given to the selection of varieties adapted to the conditions.

Along country roads, the trees should be planted in an irregular manner leaving intervals of open. A greater or less profusion of low bushy trees together with a natural planting of bushes is pleasing and productive of a rural aspect.

Along city streets the trees may be arranged in a more conventional manner, although broken rows are by no means undesirable, and a true artist will seldom remove a beautiful specimen for the sake of a sidewalk or a straight curb if room can possibly be obtained otherwise. We have all seen grand old elms and other beautiful trees cut down merely because they grew in the middle of a sidewalk, and the man who prefers the room to the company of such a tree should be considered in the same light.

When trees are planted in rows, very careful attention should be given to the distance between them. It is often necessary to place young trees near together in order to produce a satisfactory immediate effect, and if this is done the trees must be so arranged that every other one, or every other two, may be taken out later, leaving the remaining ones at a proper distance from each other.

Only too often, when necessary to remove every other street tree, it is found that the space between them will then be too great, and a little more judgment at the time of planting would have facilitated matters. In such cases it is especially hard to remove the offending specimens, and the tendency is to leave them too long until the other trees are damaged. At best it takes considerable courage to administer the heroic treatment of th axe and

the matter should be simplified as much as possible at the time of planting.

What to plant on a city street is a very important question. In the first place, many trees will not thrive where their roots are covered by brick and concrete sidewalks or macadam and other solid road beds. Under such conditions oxygen is excluded from the roots and moisture is obtained with difficulty. Deep-rooted trees are the best for such planting and the Norway maple makes one of the most satisfactory street trees for this as well as other reasons.

The purpose of street planting is not only for ornament and beauty, but also for the shade that is furnished, thus those trees which produce the best shade are favorites. They must not, however, have lower branches which will impede traffic. For this reason some trees are not suitable. Generally, however, trees may be trimmed up eight or twelve feet without marring their beauty and with the maples especially this is necessary. Pin oaks are very beautiful and grow rapidly; but the most striking characteristic of these trees is the drooping of the lower branches, and for this reason they are better adapted to lawn planting.

Most of the oaks, however, are very desirable for street planting if properly trimmed. They are generally avoided because quick effects are desired; but we should be willing to consider posterity, and he who plants a tree in order that future generations may receive the results of his work is conferring a great and lasting benefit on his community. As a matter of fact, however, many of the oaks make a fairly rapid growth and the red oak which is particularly beautiful may be considered a rapid grower and is very suitable for wide streets.

The horse chestnut is not a good choice for street planting. It is a dirty tree and the foliage drops early.

The silver maple is a rapid grower and beautiful in early spring; but it is too easily broken by ice and winds, and is very susceptible to borers especially when subjected to the difficult environment of city streets.

The red maple is not as hardy as the rock maple or Norway maple and is inferior in beauty.

The Oriental plane is a very desirable tree for wide streets. It has recently come greatly into favor because unusually adapted for such conditions; but it should not be used too generally as has been the case in many cities.

The liquidamber is a good tree in New York state and southward. It prefers low moist locations but will adapt itself to dry conditions.

The tupelo also prefers wet soils but it has a deep root system and will often do well for city planting if it is not in an exposed position.

The white ash is an excellent street tree for the east and its beauty is not effected by necessary trimming. It has a shallow, fibrous root system and prefers rich earth. Nevertheless, it generally does well as a street tree in locations east of the Mississippi.

A general rule which may be followed is the planting of medium-sized trees on narrow streets and reserving the tall and broad headed trees for wide streets and avenues. Not only do the larger trees require more room, but they are set off to a better advantage by a broad thoroughfare which will permit their beauty to be revealed from a distance.

The hickory is a tall and beautiful tree but it seems rather out of place when planted upon a street and the same is more or less true of the chestnut. The evergreens are little used for this work as they tend to darken a street and lend somewhat of a gloomy atmosphere. Of all the tall trees the honey locust, tulip, tupelo, liquidamber, the oak, especially the scarlet oak, the ash, sycamore, sugar maple, and elm are the most suitable for street planting and especially attractive on wide streets.

Probably the most noble tree for road side and city street planting is the American elm. Its limbs rise up well out of the way of all traffic and then

spread out in a superb head. Their naked ruggedness is very beautiful in winter, and in summer they are massed and dripping with beautiful swaying foliage. Single specimens lend a great deal of character to any street, and long avenues of elms will make even shabby communities beautiful.

How to Plant

In tree planting it is first important to select good specimens. If a young tree has acquired good habits of growth its chance of making a good specimen is far greater than a poor sapling which has been injured or wrongly started, or one that has lead a struggling existence. Great care should be used in selection, and stock should never be chosen because of a favorable price. Moreover, trees should only be bought from a well known nurseryman of good reputation. A tree pedlar is a nuisance to any community. His goods are very apt to be untrue to variety and we know nothing of the treatment they have received. The more care trees have received in a nursery the better fitted they are to stand the shock of transplanting. Large, scrawly roots are not desired. It is only the small hair rootlets which feed the tree and those trees which have received proper treatment in the nursery will have acquired a small, compact ball of fine roots, of which a large portion may be saved in moving and which will carry with them a good ball of earth.

The spot in which the tree is to be planted should also receive very careful attention. This point cannot be over emphasized. Wherever trees stand in cultivated fields they are forced into a tremendous growth with rich heavy foliage and beautiful symmetry, and this condition should be approached as closely as possible by putting the soil where the tree is going to stand, in perfect tilth. If possible, this should be done during the fall previous to planting.

When preparing the soil it should be "made up" to suit the tree, using varying amounts of humus, sand, silt and clay according to the needs of the tree in question. If peat or muck from swamps is used for humus, it must be treated with lime and sunshine to sweeten it, otherwise humic acids will be formed in the soil and the trees killed. It is well to have considerable gravel or sand in the top soil about trees so the rains will easily percolate directly down rather than running off at the surface.

The hole should be dug sufficiently large to permit a careful arranging of the roots, for if they are crowded the tree will never fully recover from the treatment.

After the last soil is taken out it is well to thoroughly loosen the earth at the bottom of the hole in order that the replaced earth will pack into and unite more perfectly with it. If any stones are removed the smaller ones may be scattered judiciously into the bottom of the hole to assist in draining. The surface soil should be kept by itself and replaced first as it is richer than the subsoil and will make a better bed for the roots to lie in. Before this is put in, leaf mold may be carefully mixed with it, or manure if it is thoroughly rotted. Fresh manure would cause severe injury to the roots and possibly even burn them.

While the surface soil is being placed about the roots it should be thoroughly packed in a close, firm mass. This may be done with the feet, aided by a smooth round stick, such as the handle of a hoe. Care must be exercised, however, that none of the roots be broken.

If the tree is carefully worked back and forth with the hands, the soil may be packed down more firmly. At this time, due attention must be paid to keeping the tree erect, for if not placed in an upright position, it is difficult to correct the error afterward without injury to the roots.

The subsoil is replaced last and packed as firmly as possible, and the surface should be rounded up to allow for settling which will follow.

After all the soil is in position and the planting accomplished, water should be added in sufficient quantities depending upon the dampness of the soil. It is common practice to pour water into the hole to help pack down the earth before it is all in place, but this is a mistake, for after the water has fully drained off, which will take some time, cavities will be left in the soil.

Even after the planting is finished an excess of water must be avoided. Large quantities at one time will do little harm if any, but the soil should be allowed to dry out before more water is added. Only too often, good trees carefully planted, are killed later by constant watering which excludes oxygen from the roots and dilutes the weak root acids which are necessary to render the soil foods available.

In tree planting, careful attention to all of the essential details is necessary. Good trees carefully grown and carefully packed and shipped are apt to die from careless planting, and the blame is generally placed upon the nurseryman which, in such cases, is unjust.

As stated above, it is important to select good specimens. These must be carefully shipped and if the roots are puddled to receive a coating of clay, and then bound up in wet sphagnum moss, the purchaser will receive them in good condition. It is wise to have as short a time as possible occupied in shipping. Some trees, however, may be transported for long distances, and subjected to long spells of drought without harm resulting.

Unless it is possible to plant the trees immediately upon their arrival, they should be heeled in. That is, a trench should be plowed or dug so that the trees may be laid sideways and their roots covered. It is well to give them a watering at this time, or even dip the roots into water. After the trees are taken from the trench for planting, the roots should be covered by wet burlap or canvas to prevent the sun striking upon them, for if the roots are allowed to become dry, they may be killed. This is especially true of the resinous roots of conifers.

Should any roots have been injured in shipping, they should be carefully removed, making a smooth cut. A decayed root may do quite as much damage as a decayed trunk or branch.

When placing the trees in the hole, some varieties may be set a little deeper than they formerly grew. This will place the roots a little nearer to the water table until established and the tree will find little difficulty in putting forth new surface roots. It will also enable the tree to stand more firmly until the soil has become packed and the tree firmly anchored.

Some trees, however, are liable to injury if set deeper, and in any case the difference should be very slight. Trees should never be planted less deep than they formerly grew. Of course the tree formerly grew at the proper depth, and as the time of transplanting is critical it is often safer to copy the former conditions and not attempt to teach the tree new habits.

At the time of planting, trees must receive a more or less drastic pruning. A large proportion of the microscopic hair roots are sacrificed by moving and the remaining roots are unable to obtain a sufficient supply of water to permit the excessive evaporation from the leaves and wood.

About one-half of the wood of deciduous trees should be removed. This takes courage but it is important. The selection will depend somewhat upon the variety and therefore upon the type of head desired.

Street trees should be trimmed up from eight to twelve feet according to their position. If they are very near the sidewalk eight feet will be sufficient; but if they overhang the street twelve feet will be necessary to allow room for passing vehicles.

The branches of most trees will droop as they increase in weight and such trees will be improved in appearance by this trimming if done at time of planting. If neglected then, it cannot well be done later without injury to the appearance of the trees.

Many trees should be topped at the time of planting and this will depend somewhat upon whether the tree should produce a direct leader or an open head.

Most of the maples may be stripped of their branches and topped at the height the lowest branches are desired. This looks as though it would be disastrous; but on the contrary most admirable specimens may be produced in this manner.

The sugar maple tends, more or less, to form a direct leader and caution should be used in topping it. Other trees which form upright leaders may be topped when the saplings are making two spindly a growth, if care is used to permit the formation of a new leader.

American elms may be considered to form an open head; but nevertheless, they must not be topped or they will never develop the desired characteristic type.

In growing conifers especially, success depends in a great measure upon the soil and it has been observed that trees of the same variety and growing as companions in the same vicinity, will vary greatly in size and beauty because of different soils used at the time of planting.

The best soil for conifers is a loam sufficiently rich in humus, but containing sand to insure good drainage, and this applies to the subsoil as well as the upper layers. Excessive moisture in the subsoil is very detrimental except to those trees which love the bogs and swamps and they are mostly southern varieties.

There are varying opinions concerning the best time for planting conifers.

It is best that the newly disturbed roots should be placed in their final resting place some time during the growing season in order that they may resume the performance of their functions at once.

It is unfair to subject conifer roots to the shock of transplanting either in the heat and drought of summer or cold and drought of winter, although less harm will be done in the winter if the ground is frozen, as a large root ball may then be obtained, in which case, many of the roots will not be disturbed whatever. Some expert tree movers, by means of especially devised apparatus, are often able to move large oaks, pines and other trees of great size with success, even in midsummer. When successful in this, it really seems as though they actually fooled the trees.

Probably the best time is in April when the soil is becoming warm and everything in Nature is starting into a new growth. The trees should be taken up just before the buds begin to open.

If the work cannot be done in April, it had better be arranged late in August which will allow the roots to become established before being subjected to the freezing and thawing of winter, although, as we have said, winter planting is often satisfactory if properly done.

The above applies throughout the north; but in the south conifers should be planted in November or late February.

If the growth has started before the trees are taken up, all the new growth must be carefully pruned off and this must be done evenly to keep the trees symmetrical. Other than this, no pruning should be given evergreens at the time of planting, unless there are undesirable limbs which should be removed. If a tree is in particularly poor health, some of the branches might be thinned out, but, on the other hand, such a tree should never be planted unless the specimen is beautiful after this pruning is done.

If a conifer is growing too rapidly in height and becoming spindly, the leader

may be cut out and while a new one is forming the tree will fill out into a better type. When a conifer is topped in this way, however, great care must be given to the formation of a new leader, as a double-headed conifer is not attractive. A stick tied to the trunk of a tree and extending above it will furnish support to which one of the uppermost shoots may be trained and this will quickly develop into a new leader.

If the foliage of newly planted conifers is kept wet for a few days and then partially shaded for a time, the excessive transpiration is reduced and the trees will be benefited.

After planting evergreens they should receive heavy applications of organic fertilizers, although inorganic foods may be applied if carefully balanced formulas are used.

PRUNING, TREE SURGERY AND BOLTING

Tree surgery is a pleasant and suggestive term for the art of saving fruit and shade trees which have been damaged by Nature's violence or have fallen victims to disease and decay. Its value is becoming appreciated more and more highly and it is doing much to preserve the trees which add to the beauty and charm of suburban and country homes.

Nearly every house has trees around it, parks and thoroughfares are made beautiful with trees, and, like all growing things, these trees need attention. They must be cared for and fed, guarded from the attacks of insect and fungous enemies, pruned and trained, if they are to become symmetrical and strong. The average owner bestows very little attention upon their welfare, mainly because of unfamiliarity with the proper methods of procedure.

The most important pruning is required at the time of transplanting. It is then that a tree is trimmed up and trained according to its condition at the time, the location in which it is placed, the characteristic style and method of growth, and the type of head which is desired. This subject has been previously dealt with under the head of planting, and we will now consider those trees which have attained considerable growth and are more or less mature.

Unless cared for, trees acquire a greater or less amount of dead wood. In the struggle for existence many branches fall out of the race. When crowded, trees prune themselves, and lower limbs often die from the shade of higher branches. Insect and fungous diseases, mechanical injuries, winter killing of the roots and crown, lack of mineral food and moisture, and other causes, play a part in the formation of dead wood. Whatever the cause, dead limbs must not be neglected.

There is a law which applies practically everywhere throughout nature, namely, that all living things must either progress or revert. There can be no prolonged standstill. Some movement must obtain either ahead or backward, and so it is with the tissues of trees. When, for any reason, the cambium, buds and leaves on a limb die, there can be no further advance. The lifeless or woody portion of a tree will remain sound indefinitely unless exposed to the destructive action of decay. As long as the film of live cambium is present the wood is preserved; but when this is removed or killed, decay advances rapidly from many causes. Insects, fungi, bacteria and other ferments, as well as oxidation from weather exposure, all play a part.

When, for any reason, a wound exists, and the inner wood is exposed, the cambium at once attempts to cover it. This is brought about by a sort of rolling of the cambium out over the exposed wood. This growth of callous takes place mostly from the sides and upper part of the wound owing to the downward flow of sap. Wherever a dead branch, or even the stub of one, remains upon a tree, the cambium vainly endeavors to heal the wound, although nothing can be accomplished. The new bark may protrude an inch or two along the branch, but further it cannot go. This condition is to be seen on every hand, and on a beautiful old tree it is indeed pathetic. If the limb is not removed at this stage, decay eats back into the trunk, and by the time the stub has rotted sufficiently to

fall of its own accord, an ugly cavity has formed in the trunk. All this may be prevented by removing the dead stub or limb in proper time.

When removing a limb, the cut should be made as closely as possible to the contour of the tree. This is very important. Absolutely no stubs should be permitted to remain to prevent the new bark from spreading readily over the wound. The closer the cut is made the larger will be the wound, but this large wound will heal far more quickly than a smaller cut which is made several inches from the trunk. The rule to be followed, then, is to make the largest cut possible.

All cuts should receive some protective dressing to preserve the wood until healing is accomplished. Coal tar is excellent for this purpose, as it has considerable body and will remain for a long time. A drab lead paint is also good and sometimes it is preferred.

When large limbs are removed two cuts must be made, otherwise the heavy branch will fall before the cut is finished, dragging with it a long peeling of bark from the trunk which will prove a serious matter. The greater part of the limb should be removed first by making a primary cut six inches away from the trunk, and even here care must be used to prevent stripping of the bark. This may be avoided by first passing the saw through on the under side an inch or two. After the heavier part of the limb is removed in this way, the remaining stub may be taken off without danger.

Frequently it is necessary to remove live and healthy branches from trees for various reasons.

Limbs growing in toward the center of a tree will eventually cross and chafe. Some trees, especially some of the maples, tend to produce thick, bushy heads, and it is best to remove all excess branches so the growth may be diverted into the most desirable ones. These will then become large and rugged, and the trees far more beautiful than those composed of masses of undersized limbs. When removing live branches in this manner all care should be exercised to retain symmetry and natural beauty.

Occasionally when trees are found to be in a dying condition, we have reason to believe the roots are damaged. This may have occurred from winter killing, or drought, or from construction of walks and drives. Grading, also, is frequently to blame, either by the removal of soil and cutting of the roots, or from raising the grade and burying the roots. Whenever the roots are severely damaged from any cause, the tree should receive some pruning of the crown. While developing its growth the tree has attained a balance between its crown and root system, and when any considerable number of the roots are injured, sufficient moisture to supply all the twigs and leaves cannot be obtained. The sun and winds evaporate more water than the tree can afford and the leaves wilt and become brown at the edges. Therefore, in such cases it is necessary to thin out the branches until the balance is restored between the roots and crown, in order that the tree may need no more water than the roots can procure.

There are rare cases where it is necessary to severely cut back or "pollard" dying trees. This is done to stimulate a new growth. Dormant buds are forced to develop and a new system of branches is finally produced. Several years after a tree has been pollarded it is very necessary to remove the old stubs in order to prevent the formation of cavities. Most of the young shoots must be thinned out as they appear, permitting only one or two to remain on each stub. Pollarding should be practiced most conservatively and only by an expert. No tree should be thus treated except as a last resort, as the beauty of the specimen is destroyed for several years. In many cities whole avenues of noble trees have in this way been rendered unsightly and often killed, when such treatment was entirely unnecessary. Such carelessness is almost a crime.

"Topping," however, may be more frequently practiced. There is a vast difference between pollarding, or cutting back by sawing off large limbs, and

topping, which is merely the removal of the small shoots at the top of a tree. This may be done in such a way that the growth is only arrested in that direction for a short time and the tree will be stimulated into forming a heavier growth below without severely injuring the appearance of the specimen. In severe cases this topping may be repeated after a safe interval. It is often a very effective means of filling in a tall, thin tree which has made too rapid a growth. Although this practice is much less drastic than pollarding, it should only be done by one experienced, and some trees in particular should only be topped with extreme care and conservativeness. In fact, trees should never be subjected to this treatment unless they have made a very scanty growth or there is some other definite and sufficient reason.

Small branches may be removed by means of pruning hooks, ten to sixteen feet long. Larger branches in unaccessible positions may be cut by means of a pole saw. This is merely a saw blade adjusted to a long pole and made sufficiently heavy to be effective. Both the pole saw and the pruning hook save a great deal of climbing. Pruning should only be done, however, by agile climbers who can work with ease and surety in any part of a high tree. On thick barked trees like the oak and elm, linemen's climbing spurs may be used to great advantage by experienced men.

A previous explanation has described how cavities are formed from decaying branches and stubs, and how such cavities are to be avoided by proper pruning at the right time. Only too often, however, no attempt is made to arrest decay until cavities have formed.

A cavity in a tree is really a serious matter. Even a small fissure on one of the upper branches may kill a tree in time, owing to the spreading of the decay from one branch to another and finally down into the trunk.

It is impossible for the bark to heal over a large cavity, as there is no support for the cambium to roll on. Such a cavity will rapidly increase in size until the entire trunk is hollow, and the tree goes down under its own weight or before a strong wind. It is necessary that some surface should be present on which the cambium may roll. The cavity should also be filled in order to make the tree sound once more and this must be done in such a way that the decay is permanently checked and the trouble remedied for all time.

All decayed and diseased tissues must be removed from a cavity until nothing but sound wood remains. This requires a chisel or gouge and a mallet. A heavy application of coal tar should be applied to the interior, and the fissure may then be filled with cement. In large cavities broken stone may be used to help fill up space. The best grade of Portland cement and the best quality of sand are needed for this work. If there is any silt, or organic matter in the sand, the cement will not set firmly. Three parts of sand to one part of cement will make a good concrete if it can be used fairly wet. Generally, however, when mixed very wet, cement will not remain in position, and in upright cavities it is often necessary to mix it sufficiently dry, so that when squeezed with the hand the mass will retain its shape. Under these conditions it is best to use equal amounts of sand and cement. In very large cavities it is sometimes wise to erect a brick wall near the entrance and fill the interior of the cavity with very wet cement. The surface of the brick support may then be covered by a wet cement which can be applied in thin layers plastered one upon another until the surface meets the contour of the cambium. This method is expensive but the wet cement will set exceptionally hard, harder than rock, and with extra large cavities in valuable trees it is worth while. In many cases a netting of chicken wire will provide ample support for the moist cement until it has set. This can be nailed across the cavity on the inner side of the opening. It is considerably cheaper than brick. Before the cavity is filled, it is well to drive large nails partly into the wood in the interior of the cavity, in order that the cement will set more firmly to the wood. After the

filling is in place, the surface of the cement should be puddled and troweled as much as possible, and the more of this troweling it receives, the harder the concrete will become. It is very important that the edge of the cambium should be cut, and the cement must not reach over this or even touch it. If carefully done the growing cambium will roll over the cement and even cover it, although this is not necessary. Considerable skill is required to do expert work of this kind, and the filling of a decayed tooth by a dentist requires no more care than the proper treatment of a cavity in a valuable tree.

Trees often become weakened so that heavy branches require support. Under such circumstances, iron bolts, if properly applied, may frequently preserve grand old specimens from destruction. There is decidedly a proper and an improper use of bolts. It is exceedingly injurious to fasten bolts by means of bands. Such bands, whether of iron or other material, quickly choke the limbs they touch. Growth is, of course, prohibited, the limbs become strangled, and the cambium is eventually girdled. A hole should be bored directly through the wood, through which the bolt may be passed, and a washer and nut applied to the outside for support. The washer and nut should be countersunk so the bark may quickly heal over them. Bolts applied in this way will do no harm if care is used to prevent splitting. If a single bolt is used, it is very liable to be broken by the swaying of the tree, or possibly the tree itself may be split, as the leverage of a long heavy limb is enormous. Thus it is often necessary to have the bolt in two or three parts, attached in the centre by one or more chain links. This will support the weak member and also permit the natural sway of the branches. Eye-bolts, in many cases, will answer the same purpose. That is, the bolts may each be made with a turn on the end farthest from the nut, and these can then be locked into each other. In some cases it is necessary to draw the weak limb closer to the tree, and then the bolts may each be made with a thread on each end, and a turn-buckle used to connect the bolts and tighten them.

For limbs one foot or under, 3-4 inch iron is generally heavy enough, but as the limb and leverage increases the iron should also be increased in diameter.

The higher the bolt is placed from the crotch, the less will be the leverage strain. High bolts may therefore be made of smaller iron, and they are better concealed by the foliage.

COMMON DISEASES AND THEIR CONTROL

Trees are subject to a great variety of diseases. Most of these may be controlled by man where it is possible to definitely distinguish the cause.

The diseases which attack man himself have been studied carefully for centuries, and when a physician is called in, it is generally possible for the human patient to tell something about his trouble which will assist in making a diagnosis. The science of plant pathology, however, is comparatively new. There is a great variety of diseases which only attack certain trees, and of course the tree cannot tell us anything about the history or symptoms of the case in question. The plant pathologist must rely mostly upon what he sees, his knowledge of the normal tree, his knowledge of disease, and what his judgment tells him about the history of the trouble.

When a tree has been weakened by one cause it becomes susceptible and predisposed to other diseases, and the pathologist must not mistake the secondary trouble for the actual cause.

Tree diseases may be grouped under the following heads, and we will consider each in turn, both as to the nature of the trouble and the best methods of control:

Poisoning.
Injuries from heat.
Injuries from cold.
Abnormal moisture supply.
Abnormal food supply.
Mechanical injuries.
Bacteria.
Fungi.
Insects.

This is not a true classification of diseases. Rather it is a division which we will follow for convenience.

Poisoning

There are many poisons which may injure trees either through the soil or through the leaves. Fertilizers containing muriates are apt to be dangerous, as the chlorine may be injurious. There is a constant interchange of acids and bases among the chemicals of the soil, and when muriates are used chloride of ammonia is sometimes formed, which is a deadly poison to plant life.

Sulphur dioxide has done much damage in the vicinities of smelting establishments. The gases of coal tar are very injurious, and coal gas is also responsible for much killing of vegetation.

The lichens which live on the barks of trees in the country are absent in the vicinity of cities owing to the coal gas in the atmosphere. The lichens do no harm, as they merely feed on the dead part of the bark. Wherever they are not found on the trees, we know the trees are struggling with atmospheric impurities.

Sulphurous acid gas is given off from burning coal, and in some localities it is responsible for considerable damage. Such gases enter the stomata and kill the chlorophyll.

Illuminating gas probably does very little damage by coming in direct contact with foliage, but when escaping in the soil, it becomes soluble in water and is taken into the trees, which quickly die, owing to the destruction of protoplasm. A tremendous amount of damage annually occurs from this cause. Gas pipes and mains frequently leak at the joints. When old mains are subjected to increased pressure for the supplying of larger districts with illuminating gas, the pipes are often unable to hold the pressure. It is estimated that 10 per cent of all the gas manufactured in cities is unaccounted for by the meters, and probably most of this escapes into the soil. Entire avenues of beautiful trees are sometimes destroyed in this way.

When small amounts of gas are present in the soil, the trees may struggle on for years in poor health, forming considerable dead wood, and possibly dead areas of bark on the trunks.

In cases of large leaks, the soil may become saturated with gas, and distant trees killed even when there is no noticeable odor in the atmosphere. In severe cases of gas poisoning there is little hope for recovery, for by the time the trouble is discovered the damage is irreparable. The upper leaves are apt to be affected first. The foliage becomes yellow and falls and the bark takes on a dark appearance. In the spring, the inner bark and sap wood acquires a disagreeable odor, and in the summer the tissues become noticeably dry. Very soon the bark comes away from the trunk, and this is a characteristic of gas poisoning, for in other diseases the bark adheres until long after the trees are dead. There are several kinds of fungi which attack a "gas tree" and often completely infest the dead parts in a very short time.

When trees first show symptoms which appear to be due to gas poisoning, the roots should be carefully examined, for the first roots affected will indicate the direction of a possible leak. Then careful examination of the soil will reveal the unpleasant odor of condensed gas, and the leak may be located. Property owners should force the gas companies to keep their mains in repair, and when trees on or in front of private property are killed, the owners may recover damages from the gas companies.

Injuries From Heat

The story of the yearly damage done by forest fires is appalling. We are apt to overlook the harm resulting from small ground fires, but every year many trees are seriously damaged in this way. Gardeners and care-takers burn over the ground to destroy dead grass and leaves, thinking no harm will result, but

the tiny flames are only too often hot enough to kill the cambium and girdle the trees.

Many fine specimens are injured from the heat of burning buildings. Unless too many of the limbs are destroyed on the side nearest the fire, the trees may often be saved. The dead bark should be pulled away to prevent its harboring insects and fungi, and the exposed wood should receive a protective dressing of tar or paint.

Sun scorch is a term applied to several troubles, which for want of a better place, we will describe under the heading of heat injuries.

When strong winds prevail for any considerable time during periods of drought, many trees suffer from a scorching of the foliage. This is true of evergreens as well as deciduous trees. The hot, dry winds whip the foliage and draw moisture from the leaves faster than the roots can procure it from the soil.

Thus sun scorch is really a temporary drought, forced upon the trees by excessive transpiration. Trees which stand in sandy soil are especially subject to it, and the maples are commonly affected. The leaves become dry and brown on the edges, and the inner surface appears sickly.

The leaves do not fall, however.

Occasionally only that foliage which faces the prevailing winds will appear scorched, and in other cases, entire single maples will stand out brown and dry in the midst of surrounding trees of healthy green. In such severe and solitary instances the trees are growing in sand or gravel, or the roots are subjected to some uncongenial conditions.

If heavy watering is possible the damage may often be checked as soon as noticed. Large amounts of water are necessary in order that the soil may be entirely saturated in the vicinity of the scorched trees. Then the ground should be allowed to dry out before more water is added in order that oxygen may get to the roots and prevent suffocation.

We have seen sun scorch checked in maples which were previously affected each year, by allowing a slow stream of water, from a garden hose, to run upon the ground over night and stopping it in the day time. The trees thus treated remain until fall in good condition, while the surrounding trees, annually affected, were very badly scorched.

Most trees are liable to sun scorch under certain conditions.

The conifers and other evergreens are most apt to suffer at the end of winter. When the warm winds of spring come before the frost is out of the ground, injury is very prevalent. Moisture cannot be obtained by the frost-bound roots in sufficient quantities to supply the foliage. Arbor Vitae and rhododendrons are frequently sun scorched at this time. Whenever a mulch is used around evergreens it should be removed in the late winter in order that the sun may quickly thaw out the frost.

Injuries From Cold

Under certain conditions trees suffer severely from cold. Sleet storms, which form thick coatings of ice over the branches, cause much wreckage. The limbs become brittle and the weight excessive.

Tissues of certain trees are better adapted than others to cold weather. Trees indigenous to wintry climates have their tissues so constructed that the wood can actually freeze without harm resulting. When the dormant winter season approaches, the sap and moisture is drawn into the centre of the cells, so that, when freezing occurs, there is room for expansion and the tissues are not ruptured. With many tropical trees this is not true, and when the moisture of such trees is subjected to freezing, the tissues are broken down.

Exotics, or foreign trees, even though they may not be tropical varieties, are more apt to winter kill than native trees which are indigenous to the locality in which they are growing. And yet, most trees, even in their natural habitat, are very subject to winter killing under unfavorable meteorological conditions.

It occasionally happens that very dry summers are followed by heavy rains in the early fall. This tends to start a late growth which does not become

ripened before the cold weather, and during the winters of such years, a tremendous amount of damage is done to tree life by winter killing. Pines, maples and birches are especially liable to suffer in this way, and the trouble is due to the previous seasons, rather than to the actual cold weather. In fact, cold weather can do little, if any, harm to trees native to the temperate climate.

If trees are fertilized too late in the season, the same result occurs, as a late growth is produced which cannot mature before the dormant season arrives. If fertilizers contain a sufficiency of phosphoric acid, less harm will be done, as phosphorus tends to ripen the tissues.

It is thought that periods of extreme cold weather, occurring when the ground is bare of snow covering, are responsible for much killing of the roots. This is without doubt very true, as at such times the frosts penetrate to an unusual depth and reach deep roots which are not generally touched and therefore less able to withstand the action of freezing and thawing.

Trees which are in poor health from other causes are more liable to injury from winter killing than strong, healthy specimens.

There are different degrees of winter killing. Many branches die each year, branches that have made a tender growth and not become matured. When certain roots have been frozen, corresponding portions of the crown may become affected. In the year 1905 the white pines were severely injured over large areas. The tops died, and for a time it was thought that some new insect enemy of the pines was responsible.

Occasionally both the root systems and crowns of trees are killed in this way. The roots alone may be killed, or only the crowns may be damaged.

If the roots are killed, the trees cannot recover. By digging up the soil one may examine the roots and ascertain the amount of damage. If the crowns alone are killed, new suckers and shoots will arise from many trees and thus replace them. With such varieties, if no sprouts appear we may be sure the roots have been killed.

Extreme cold weather often produces frost cracks on the trunks and limbs. These occur in lines following the direction of the trunks and limbs and are due to excessive moisture in the bark and sap wood. They are distinct from winter killing, and are merely local. The combination of frost and sun appears to be largely responsible for the cracking of the tissues, and where the branches partly shade the trunks this trouble is less frequent.

Frost cracks occur most often on fruit trees, but shade trees are also affected. During the summer they close, but bleeding occurs, and in many cases so freely as to prevent healing, and then they open again the following winter. This bleeding is aided by fungi and bacteria, and other low orders of plant life, and frost cracks are very apt to become large cavities. They should be thoroughly cleaned out, the cambium cut, and the wounds treated with protective applications so that normal healing may occur.

Closely allied to winter killing is a trouble known as sun scald. This has every appearance of being due to some invading organism, but it is probably merely due to the action of frost and sun upon unripened tissue.

Sun scald is more prevalent on fruit trees, especially the apple, where it sometimes resembles collar rot, but it also occurs on shade trees, especially the pines and lindens. The limbs and trunks are affected, but the lower part of the trunks are most subject to it. During the following summer the bark dies in areas and falls from the wood. These areas should be cleaned out and carefully treated with a protective dressing. If the areas circle the trunks, the trees, of course, become girdled and are beyond saving.

If the branches of the trees are allowed to offer a protective shade to the trunks, there will be little danger of sun scald. In all probability the damage is done by the thawing rather than the freezing, and if the full force of the sun is not allowed to beat upon the frozen wood, the frost will come out gradually and little harm will result.

In Florida it has been found that citrus fruit trees, which are usually killed by freezing, may often be saved if they are kept shaded while the frost is coming out of the tissues. If we could tell when winter damage has been done to our

northern trees, sun scald, and even considerable winter killing, might be avoided by shading the bark at the time of thawing.

Abnormal Moisture Supply

The relation existing between a tree and its moisture supply has been previously explained. Water is necessary to bring soluble food, to keep the new, tender cells fully distended, to aid in the manufacture of starch in the leaves, and to liquify the digested products of the leaves into sap which may flow through the different channels to all parts of the tree. It is very obvious that when, from any cause, the normal water supply is shut off, the entire physiology of the tree is upset.

We have seen how droughts are partly responsible for many other troubles. Dry spells in the spring, accompanied by hot winds, produce sun scorch. Summer droughts followed by fall rains induce late growth which easily winter kills. Altogether, droughts do immeasurable damage to tree life.

Very often trees, especially those under cultivation, suffer from droughts which are merely local. Pavements of streets and sidewalks exclude moisture and force it to run off in gutters and cess pools. Those trees, however, which can adapt themselves to such dry conditions, are less harmed by unusual periods of drought than trees in other locations, as the very pavements which exclude rains, tend to conserve what moisture may exist beneath them. Space free of pavements should be permitted near the base of a tree, as much for the entrance of oxygen as for moisture.

Drives and walks, when first put in, do much damage to trees, even in cases where great care is used not to injure the roots. Gravel and crushed stone are frequently used for the under bed of such paths and drives, and this drains the neighboring soils. Grading, also, does much damage, as it raises or lowers the water table. The burying of roots with extra soil, in the raising of grades, may do quite as much damage as the removal of soil and cutting of roots. Here, again, the lack of oxygen may be as disastrous as the lack of moisture. Wherever roots are subjected to an excess of moisture, the trees are killed from lack of oxygen.

When trees are subjected to any of the above disturbances, they at once begin to build a new root system, and thus attempt to adjust themselves to the new conditions, and unless too much damage is done in the meantime, the trees will gradually recover.

Very often when, from any of these reasons, trees are found to be in poor health and appear to be dying, they have, in truth, received the full extent of the damage and are beginning to recover. Whether or not this is true is a difficult matter to determine, but the fact that it may be so, makes it worth while to give all possible care to such specimens in an endeavor to save them. All dead wood should be removed from such trees, together with some live wood, and fertilizing practiced to stimulate new growth.

In severe cases, cultivation and cover crops may be used as a means of controlling the moisture supply. If there is an excess of moisture, grass should be allowed to grow tall, as it will then take up a tremendous amount of water by transpiration. Tile draining is also most effective. If there is a dearth of moisture in the soil, the grass should be kept closely cut. In very severe cases, the sod should be plowed under and the ground cultivated during the dry season. This will produce a dust mulch and break up the capillary tubes which form in the soil, so that evaporation may be checked. This is, of course, not practical on lawns where grass is desired, but it is very essential in the culture of fruit trees.

Abnormal Food Supply

The food of trees has been explained in the first chapter under the subject of "Growth." The great bulk of the food comes from the atmosphere in the form of carbon, but small quantities of earthy constituents are needed, and these should be supplied in proper amounts.

Whenever a lack of one of the foods occurs, the process of digestion is

retarded, and if this is accompanied by an excess of other food constituents, the digestion may become abnormal, which will result in physiological troubles. For this reason it is important that fertilizer should be applied in well balanced formulas.

For instance, if clear nitrates are added a quick growth results, but the tissues produced are liable to be unhealthy. With the rapidly growing fruit trees, in the sands of Florida unbalanced fertilizers quickly produce abnormal results, and the same action occurs to a less marked degree with our slower growing trees of the northern states.

Occasionally the foliage of trees becomes spotted with whitish or yellow markings. This is attributed to indigestion and it shows an excess of food rather than a lack of it. When trees have been cut and new shoots spring up, the leaves are apt to have these calico markings, because the large roots of the old trees supply more food than the leaves of the new shoots can digest.

When trees are making a slow growth, nitrates should be added. Phosphorus is necessary to ripen the tissues, and potassium is a vital agent in the manufacturing of starch. Humus is a very essential ingredient of the soil for the growth of plant life. Humus contains more or less food, but it is not directly a food itself. It is composed of fibre from partially decomposed plant tissues, and it serves a very vital purpose in the retaining of plant foods in the soil. Whenever a good supply of humus is present in the soil, trees have little difficulty in finding ample food, but when humus is absent the soil is unable to retain those materials which trees require. For this reason some soils require the addition of well-rotted manure, leaf mould, or other decayed vegetable matter, merely for the fibre which is contained in these dressings. Of course any food present will make the humus all the more efficient.

Mechanical Injuries

We all know how trees are subjected to injuries and wounds which cause disfigurement. Many of these may be avoided by proper precautions and protective laws.

Much harm is done to street trees by the teeth of horses and the contact of passing vehicles. Trees especially exposed to such injuries, and young trees in particular, should be protected by guards. Care should be taken that the guards are large enough to permit room for growth, otherwise the guards themselves may eventually damage the trees severely, and this often happens.

In many communities where there are no laws to prohibit it, storekeepers and merchants fasten signs to trees. These signs are not only disfigurements, but they are responsible for many cavities. Placards and bill posters are also very objectionable, and good citizens should protect their communities from these nuisances by the enactment of efficient laws to be carefully enforced.

Electric light and telephone wires are probably responsible for the largest amount of damage. Such wires are either attached to the trees or so placed that chafing results.

Frequently it is really desirable to have wires attached to trees in order to avoid unsightly poles. This may be done in such a way that little or no harm will result. Only too frequently, however, wires are wound about trees as a means of fastening. Either total or partial girdling is bound to result. The one will quickly cause death to the entire tree, and the other will kill the bark at the points of contact, and cavities will form later. When it is desirable to fasten wires to trees, it is best to pass bolts directly through the trunks. The wires may be fastened to the bolts, using effective means of insulation, and, if properly done, no injury will follow.

Especially to be deplored and fought against is the cutting of limbs by wire companies in order to make room for wires. Many such corporations have no heart, and avenues of beautiful trees are ruthlessly made unsightly, merely because it is cheaper to cut a path for the wires than to avoid the trees or attach the wires to the trees by insulated bolts properly applied. Many cities have forced their wire companies to make a proper adjustment of wires, and other cities and towns should prepare themselves to enforce such protective measures.

A tree warden or deputy assistant should be detailed to this work with sufficient authority to enforce the work done according to his direction. It is evident that such a man should be equipped with good judgment and a fair knowledge of tree life.

Much trouble and danger may be avoided by gathering the wires into one cable. Better still is the method of burying the wires in underground conduits. This also does away with poles.

A large amount of damage is annually done to trees by electricity from live wires. Even when originally insulated, the protective covering is easily chafed off by contact, and during wet weather a film of water is formed over the tree which furnishes a circuit with the ground.

There are two kinds of damage done to trees by electricity from wires. If the wire contains an alternating current, such as is generally used for lighting, the polarity alternates very rapidly and severe burning occurs, producing an ugly wound. This, however, is local. The burning does not extend beyond the point of contact, as the current is dissipated over the moisture on the tree. When, however, wet trees are touched by wires carrying direct currents, such as are used in trolley wires and power cables, the entire cambium may be killed. In a direct current, the polarity is constant, and electrolysis may disintegrate the protoplasm throughout the trees thus charged, and the specimens actually become electrocuted. This action does not always occur, as ordinarily a trolley wire will merely burn a wet tree at the point of contact, just as an alternating current acts; but in cases of reversed polarity, which sometimes occurs, the trees are also burned at the base where they come in contact with the ground.

Lightning does considerable damage to some trees, while others are never injured. Those trees which contain an excess of fats and oils, such as beeches and birches, are never struck by lightning.

A lightning bolt may rend a tree in fragments or it may do very little harm. Occasionally a stroke of lightning will do little or no visible harm to a tree, and yet diffuse itself through the tissues in such a way that the entire cambium is killed. After a tree has been damaged by lightning, it is best to wait until the following spring before any attempt is made to repair it, as the cambium may have been killed in this way. If the tree produces a spring growth, the repairing should then be done.

Sometimes trees are damaged by earth discharges. The electrical potential between the earth and the atmosphere is frequently reversed, and at such times earth discharges may be given off from wet trees.

Dr. Geo. E. Stone of the Massachusetts Agricultural College, who has made a deep study of the subject of electricity and its relation to plant life, and to whom we are indebted for our information, states that earth discharges are accompanied by peculiar sounds resembling those caused by throwing damp clothes against hard surfaces. The foliage quickly wilts after these discharges, splitting is generally found to have occurred, and many limbs die.

Bacteria

A very important part is played by the action of certain economic kinds of bacteria upon tree life. Most of these are friends, but some are enemies. A few kinds are very important.

The nitrifying bacilli which live in the nodules on the roots of legumes carry on a symbiotic relation with their hosts, procuring nitrogen from the air, and furnishing it to the roots in exchange for starch. There are also denitrifying bacilli which live in cold, damp soils and liberate nitrogen in their endeavor to obtain oxygen. These rapidly waste the nitrogen supply of the soil and are therefore enemies of trees. When the soil is drained and aerated their action ceases.

Bacteria often feed on decaying tissue, especially in wet cavities, and their action does much to enlarge such cavities.

Fire blight is distinctly a bacterial disease, most prevalent on fruit trees. It attacks young shoots and the tips of branches. It quickly runs through the

tissues, destroying them in a night and leaving the leaves perfectly black. This disease is probably spread by bees which inoculate the blossoms.

The only remedy for fire blight is gained by removing the diseased wood and carefully burning it. The infested branches should be cut considerably below the trouble.

Fungous Diseases

Fungi are low orders of plant life containing none of the green coloring matter which we call chlorophyll, and as they have, therefore, no means of manufacturing starch, they are obliged to procure it ready made. To be absolutely correct, it would be more true to say that as they are able to procure starch it is not necessary for them to manufacture it, and therefore they are not provided with chlorophyll. This is an expression of the old law that "use makes and disuse does away with."

There are two distinct classes of fungi. Saprophitic fungi live on dead tissue and therefore do no harm. In fact, they have an important economic value as scavengers of dead vegetable tissue. If different agencies, such as fungi, bacteria, oxidation, etc., did not destroy dead vegetable products, they would petrify, and soon all the plant food in the world would become unavailable. Thus, saprophitic fungi do their part in furnishing growing trees with humus and plant food. We have also previously seen how the symbiotic fungus, mycorhiza, helps to directly feed certain trees.

Parasitic fungi live on growing tissues and destroy them. A large amount of tree growth is annually killed by parasitic fungi, and everywhere trees are more or less severely damaged by many different kinds.

The main body of a fungus is composed of what is termed mycelium. This is merely a mass of interweaving threads called hyphae. Under proper conditions, fruiting bodies are given off, which bear spores. The spores are very minute and serve the same functions to fungi as seeds do to higher forms. The fruiting bodies appear on the surface of the host and are the only portions generally seen. They take on characteristic shapes and structures according to the variety of fungus, some appearing as cups, some as round balls, etc., and they show a variety of colors and sizes, some being large but most of them very minute. The mushrooms and toadstools are merely fruiting bodies, and are the kind we are most familiar with, although not necessarily the most important. Yeast is a fungus, used in making bread because the gas it generates causes the dough to rise. Moulds and mildews are also fungi.

Different fungi attack various parts of trees, some living upon the roots, some upon the trunk and branches, others upon the leaves, and still others confine themselves to the fruit. Some may attack all the tissues.

Certain fungi require alternate hosts. That is, part of their life history is carried on in one tree and part in another, which is an important point in their control. For instance, the apple rust is found in the so-called cedar apples on cedar trees, and another rust requires both the larch and poplar for its development. If, then, one of these hosts is prohibited from certain vicinities, the disease will be controlled, and this method may be practiced in severe cases.

The fungi which attack the woody parts of a tree are the most difficult to control, as the mycelium buries itself in the tissues and is not reached by spraying. Some fungi may infest a tree for fifty years before any fruiting bodies appear. The spores gain entrance to the host through wounds on the bark, and if a tree is kept sound and in strong health it is not liable to be attacked.

The agaricus fungus attacks the live roots of many kinds. The fruiting body has a mushroom structure and is, therefore, far larger than the fruits of most fungi. In fact, it is one of the very few parasitic fungi to take the mushroom form.

Most of the parasitic fungi which attack the wood and bark do not form large fruiting bodies. They eat into the tissues and may produce large scars. Of these, canker, black rot, nectria, and black knot, do the most damage. A new fungus has recently appeared on the chestnut, which is doing an appalling amount of damage in certain districts. This feeds in the cambium and it is therefore not controlled by spraying.

Those fungous diseases which attack the leaves and fruit may generally be controlled by spraying, but if not prevented they are often responsible for much damage. Leaves are very subject to scab, pink mould, rust, leaf spot, blight, and various other diseases.

Solutions of copper have proved to be a remedy for fungous troubles. If applied in an uncombined form, these will destroy the host as well as the disease, but by combining sulphate of copper with lime, in the form of Bordeaux mixture, we produce a very safe and successful fungicide.

Bordeaux mixture should be carefully made. The "3-4-50 solution" is sufficiently strong. Three pounds of copper sulphate should be dissolved in 25 gallons of water, and four pounds of fresh burned stone lime, very carefully slacked, using only the large lumps, should then be diluted with water to make twenty-five gallons of milk of lime. After these materials have stood twenty-four hours, they should be poured together carefully and simultaneously into a third barrel through a cloth strainer. When sprayed upon the trees, this will entirely control many of the most injurious fungi.

Insects

Entomology is a broad study in itself, and we will consider it briefly, merely touching upon those insects which frequently do considerable damage to shade trees and forests, and describing the best methods of control. Those insects which ravage fruit trees are dealt with under the separate subject of fruit growing.

Insects are known biologically as hexapoda, or six-footed, air-breathing arthropoda. Only a very few insects are true bugs, but all bugs are insects. All insects undergo a metamorphosis, the amount of which varies with each species and variety. That is, during its life cycle, an insect passes through various stages, in each of which it may possess a totally distinct structure from its previous or next succeeding form.

A thorough knowledge of the different stages in the life history of insect enemies is very important in combatting them, as the majority are only damaging in one period, and most of them can only be controlled at certain stages.

In view of the remedies and methods employed against injurious insects, we may conveniently classify insect life under three heads, namely: leaf eating, sucking and boring insects. This will include the most important insect enemies of trees, and therefore answer our purpose.

The leaf eating insects, namely, those which pass certain stages of their life histories in the caterpillar or larva form, are easily controlled by poisoning their food. Caterpillars and other larvae are equipped with chewing mouth parts, and obtain their sustenance by devouring the foliage. If, then, we spray the leaves with poisonous chemicals, the insects are destroyed, but this treatment must be administered with caution.

It will at once be seen that our problem is to destroy the protoplasm of the insect without injury to the protoplasm of the tender growing leaves. Arsenical poisons are very powerful, and of these, arsenate of lead has proved the best for this purpose. It is made by combining acetate of lead with arsenate of soda in such a way that the arsenic becomes insoluble in water. For this reason it may, if properly made, be applied at any reasonable strength without danger of scorching the foliage. It is, however, soluble in the weak acids of insect digestion, hence its value as an insecticide. It possesses the additional virtue of clinging to the leaves for a long time. By spraying with this chemical, we are able to protect our trees from leaf-eating insects, and such a material is called a stomach poison.

When spraying, the materials should fall upon the foliage in the form of a mist, so that tiny particles will be everywhere present on the leaves, but the leaves should not be allowed to become wet and drip. From two to eight pounds

of arsenate of lead should be used with fifty gallons of water. The strength should vary according to the size and resistance of the larvae.

When fungous diseases are also present, the arsenate of lead may be diluted in Bordeaux mixture instead of water, thus making a combined fungicide and insecticide, and one spraying will answer the dual purpose.

Sucking insects must be combatted in a different way. They settle down early in life, and each inserts a proboscis into the sap wood. By this means the vital juices are extracted. It is evident that we cannot poison their food, and therefore we must kill them by contact. Oily preparations will form a film over them and thus kill them by suffocation. If they are naked, soft-bodied insects, the matter is very easy, as their breathing pores are easily stopped and they quickly suffocate.

If this spraying is done in the summer, certain oil preparations must be used which will not damage the foliage.

The scale insects protect themselves by forming a scale covering, and are therefore so resistant that, in order to destroy them, we are obliged to spray in the winter time when the trees are dormant, as any material sufficiently powerful to kill the insects under their scale covering in summer, will also kill the foliage and injure the trees.

The soluble or miscible oils which are offered in the market to-day are far more easily handled than the old lime-sulphur solutions formerly used for this purpose. They may also be used, in a more diluted form, in the summer time, for the naked sucking insects. Such materials are called contact poisons.

Of the boring insects, those which do the most damage bore into the bark and wood where spraying will not affect them. A wood borer may be killed by running a soft wire into the hole until the larva is pierced. Or if carbon bi-sulphide is squirted in and the hole stopped up, the liquid will become a gas and the larva suffocated.

The bark borers work in the cambium and are very liable to girdle the trees. The shot-hole borer is so called because of the many holes made in the bark by the adult beetles as they emerge. When such holes appear, the damage has been done, and the affected trees should be cut down as soon as noticed, and burned immediately. Such trees cannot be saved, and after the first holes appear, the beetles continue to come out and fly to other trees. Thus hasty action is necessary to destroy the beetles in the infested trees, in order to save surrounding trees. These borers are not apt to attack sound, healthy specimens.

SAN JOSE SCALE.

This insect, which has been called "the mighty atom," was imported from China into the San Jose Valley of California. Since then it has spread over the country like fire, and within a very few years every fruit tree in North America which is not protected will be killed by the ravages of this tiny sucking insect. Many of the shrubs and some of the shade trees are also affected, and it is somewhat feared that the scale may become more prevalent on shade trees as time advances.

The scale is not easily seen by the naked eye, being considerably smaller than the head of a pin. It is circular, and brown or brownish black. About the middle of June the yellow young commence to be born alive, several appearing each day for a month or more, and by that time the first born have become adult, and are themselves reproducing. This process is kept up until cold weather, and if all the family produced by one female insect during the summer should live, by frost time the family would number over 3,000,000,000.

The young insects crawl around for several days and then each inserts a long proboscis into the sap wood, and, if a female, it remains in that spot the rest of its life. Waxy secretions are thrown off from its back and this forms the scale cover. In the fall the male insects emerge, possessing wings. In the winter, only part of the females remain alive under their scales. The young are

spread by being carried on the feet of birds during the summer, and on nursery stock.

As the young are constantly appearing, it is impossible to control this pest during the growing season, as any practical means of killing the insects beneath the scales will also injure the foliage. The trees should be sprayed in the fall after the leaves have dropped. In very severe cases it is best to spray again late in the winter. Lime-sulphur solution is very effective, but corrosive and extremely disagreeable to make and handle. The miscible oils are very easy to apply, effective, and safe if properly used. New chemical preparations of lime and sulphur are appearing on the market, and these may prove very desirable.

OYSTER SHELL SCALE.

The scale covering of this insect closely resembles a very small oyster shell, from 1-16 to 3-16 of an inch in length. It resembles the mussel shell even more closely, and is gray or brown in color. The ash, poplar, willow, and many of the shrubs, as well as the apple and pear, are commonly affected.

In winter, under each female scale, is the dead insect and from two to eight dozen yellow eggs. The eggs all hatch about the first of June, and the yellow young crawl around for a few days, then settle down and live in the same way as the San Jose scales, except that there is only one or possibly two broods during the summer.

During the first two weeks in June, when the young are unprotected, spray with whale oil soap, one pound to six gallons of water; or with one of the miscible oils greatly diluted according to the material used. Two sprayings, ten days apart, are most effective. The oyster shell scale may also be sprayed in the winter in the same way the San Jose scale is treated, but the winter sprayings are not as effective as with the San Jose scale and the summer spraying is preferred when possible.

SCURFY SCALE.

This insect is very similar to the oyster shell scale, and feeds on the same trees. The scale is a little different in form, and the eggs and young are purple.

The treatment is the same as for the oyster shell scale.

PLANT LICE OR APHIDS.

These, also, are sucking insects, but they have no scale covering. The bodies are soft, and yellow, green, or black in color, either with or without wings. Some of them are wooly.

The young are born alive, but, with the exception of the last brood, they are produced from unfertilized eggs, which process is called parthenogenesis, and is very unusual throughout the entire animal kingdom. All the young produced during the summer are females, and each in turn produces about one hundred offspring. If all the offspring from one female insect during a summer should live, the number would amount to about 1,000,000,000,000,000,000. The last brood, produced just previous to cold weather, is partly composed of males. This brood lays fertilized eggs which pass the winter.

On the upper side of the abdomen of an aphis, two tubes are born which secrete a sweet, sticky substance called honey dew. We often see ants swarming over a tree for this honey dew, of which they are very fond. The ants do no harm to the tree. They often carry the eggs of the aphids into their nests under ground, and when the insects are born, the ants care for them and feed them for the honey dew produced, in the same way as we keep cows. The leaves of trees often become coated and sticky with this honey dew, which is liable to become infested with a fungus covering the leaves with a black substance resembling soot. Thus, the plant lice injure trees in two ways. The insects, themselves, suck the juices from the leaves, causing them to curl, and the fungus, although a secondary trouble, stops up the stomata and produces suffocation, as well as keeping the sunlight from reaching the chlorophyll.

The plant lice may be controlled by spraying in the growing season with whale oil soap, or dilute micible oils.

TUSSOCK MOTH.

This insect, like all the moths and butterflies, has a complete metamorphosis. The damage to trees is done in the caterpillar form, and the pest often becomes very serious.

The eggs are laid in the fall, on the old cocoons, just after the females emerge, and the cocoons are generally attached to the bark of the trees. The winter is passed in the egg stage, and in the spring the caterpillars crawl to the leaves and devour them. In early July the full grown caterpillars make their cocoons. There are two broods.

The tussock moth may be combated in two years. The cocoons with the egg clusters may be picked off any time during the winter, and burned; or treated with creosote to prevent hatching. Or the foliage may be sprayed with arsenate of lead. If the trunks of those trees which have not been affected are banded with a sticky substance, such as crude tanglefoot, the caterpillars will be unable to ascend.

GYPSY MOTH.

These are only found in a comparatively small locality in this country, but where present, they are responsible for frightful damage. The gypsy moths were imported from Europe into Medford, Massachusetts, by an experimenting French scientist, endeavoring to produce a tougher silk. Some of his caterpillars escaped, and the pest, being free of its natural European enemies has spread throughout eastern New England. The adult female moths can fly but little, therefore the insect spreads slowly. The caterpillars, however, as well as the egg clusters, which are laid on any convenient surface, may be carried by attaching themselves to vehicles, freight trains, etc., etc.

Gypsy moth caterpillars will devour almost any kind of foliage, and entire communities are sometimes stripped bare. Large amounts of money have been spent by states, cities, and private owners, endeavoring to control the pest and save the trees, in some cases even reaching the amount of $1,000.00 per acre.

Late in July the eggs are laid in masses about the size of 5-cent pieces, and covered with coatings of yellow hairs from the abdomens of the females. These egg clusters are depositied on the trunks and lower limbs of trees, in stone walls, on houses, amongst debris on the ground, and in fact, anywhere the adult moths may alight. The winter is passed in the egg stage, and in the spring the caterpillars feed until early July. Then they enter the pupa state, and emerge in a few weeks as adult moths.

If the egg masses are painted with creosote, during the fall and winter, the eggs will not hatch. If the trees are banded with narrow strips of burlap, the caterpillars will hide under the burlap in the day time, and may be found there and killed. If trees are banded with sticky tanglefoot early in the spring, the young caterpillars cannot crawl up the trunks. If the trees are sprayed with arsenate of lead, the caterpillars are killed.

It is often necessary to use every possible means of combating the gypsy moth.

BROWN TAIL MOTH.

This pest was brought from Europe and introduced into about the same locality as the gypsy moth. This also feeds on most shade and forest trees. It spreads rapidly as the moths are good flyers, and the caterpillars often strip the trees of their foliage.

The eggs are laid on the bark and leaves late in July, and soon hatch. The small young caterpillars feed a very little at that time, and then spin silky nests at the tips of the uppermost twigs. The winter is passed by the small young caterpillars within the nests, and in the spring they crawl out and feed. In June they enter the cocoons, and emerge in July.

The caterpillars shed barbed hairs which float about and cause a severe irritation to people by entering the skin.

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The brown tail moth nests should be cut off in winter and burned. Sometimes a spring spraying with arsenate of lead is necessary.

FALL WEB WORM.

The caterpillars of this insect feed on the leaves in late summer. They are always inside of their nest which is a large silky web, therefore spraying will not reach them, as the web is built ahead of them as they proceed.

The webs should be cut off and burned.

FOREST TENT CATERPILLAR.

This receives its name from a resemblance to the apple tree tent caterpillar, but the name is not well chosen, as it does not produce a tent, or web nest. The egg clusters are banded around the twigs, and the edges of the bands end abruptly, while with the apple tent caterpillar the egg clusters are bevelled at the ends.

This insect occasionally gets ahead of its enemies, and at such times it does much damage for a year or two.

It is easily controlled by spraying with arsenate of lead, when the caterpillars are feeding in the spring.

CANKER WORM.

Two kinds of canker worms occur, one in the spring and one in the fall, and they are distinct varieties instead of different broods.

The eggs of the fall canker worm are laid in the fall, while those of the spring canker worm are laid in the spring. The feeding is done about the same time in the spring. When the fall canker worm caterpillars are frightened, they spin a silk thread and lower themselves to the ground.

If the trees are banded with tanglefoot, both in the fall and spring, most of the caterpillars may be caught. If the foliage is sprayed with arsenate of lead during the feeding season, the caterpillars will be killed. About four pounds of lead to fifty gallons of water is sufficiently strong.

ELM LEAF BEETLE.

The larvae of beetles are called grubs instead of caterpillars, and the larva of the elm beetle is a wide spread nuisance.

The insects pass the winter in the form of adult beetles, which hide in houses, stables, etc. In the spring the beetles come out and eat small round holes in the young leaves. At this time they do no real harm. After the eggs are laid, the old beetles die. The eggs are deposited in little clusters of 15 to 20 or about 600, from each female altogether. In about a week, the young grubs hatch and feed on the underside of the elm leaves, which they skeletonize. After about three weeks they crawl down the trunks and pupate in crevices near the ground, but not in the ground. In a week or more, the beetles emerge. In many parts of the country two broods occur.

Banding the trees with stick substances does no good. When the pupae are dormant at the surface of the ground around the trunks, they may be destroyed by spraying them with strong whale oil soap. The best method of control is to spray the under side of the leaves, as soon as they are full grown, late in May or early June, with arsenate of lead at the strength of four or six pounds to fifty gallons of water. In very severe cases, the poison may be used stronger.

Occasionally a second spraying is necessary for the second brood.

It is very important, in fighting this insect, to spray the under side of the leaves using a fine mist.

Any further information desired, regarding methods of fighting insect pests, or advice concerning materials and necessary apparatus, will be gladly furnished by the Boston Nature Bureau.

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